OLUME 15
PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.
1939 NUMBER 4

ECONOMIC GEOGRAPHY

NOV 27 1939

OCTOBER

EL-'IRAQ
Hans H. Boesch

EVOLUTION OF SHIPBUILDING IN SOUTHEASTERN MASSACHUSETTS
Paul Huffington and J. Nelson Clifford

BARROW IN FURNESS: A POPULATION STUDY
T. H. Bainbridge

EUROPE'S FUEL AND METAL DEPOSITS EVALUATED
Quentin D. Singewald

THE PETROLEUM INDUSTRY OF THE GULF COAST SALT DOME AREA
Virginia Bradley

AGRICULTURAL DEVELOPMENT OF NEW BRUNSWICK
D. F. Putnam

DRY-FARMING REGIONS IN UTAH
Norah E. Zink

LARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

Dr. Boesch, honorary fellow from Zürich, Switzerland, in the Graduate School of Geography, Clark University, in 1934–35, spent 1937–38 in Iraq as petroleum geologist traveling over much of the Near and Middle East, and surveying carefully much of Iraq's territory. Now assistant professor at Zürich State College, at present he is, like most of his countrymen, serving in the armed forces of Switzerland guarding the neutrality of his country and protecting its borders.

Mr. Huffington who attended Clark University in 1928–29 and received his M.A. in June, 1929, has since been in charge of the geography department at State Teachers College at Bridgewater, Massachusetts. At present he is working with J. Nelson Clifford on a series of articles on "The Evolution of Shipbuilding in New England."

Mr. Clifford received the Master's degree from Clark Graduate School of Geography, and the B.S.Ed. from State Teachers College, Bridgewater, Massachusetts. He is now teaching in Quincy, Massachusetts. His article on Quincy granite appeared in the April, 1939, issue of ECONOMIC GEOGRAPHY.

Mr. Bainbridge received his B.Sc. degree from Armstrong College, Durham University, in 1926, and his M.Sc. degree from Armstrong College, Newcastle-on-Tyne in 1934. He has been actively engaged in research, having contributed an article for the April, 1936, ECONOMIC GEOGRAPHY. He is at present Head Master of the Creighton School, Carlisle, England.

Dr. Singewald, A.B. and Ph.D. from Johns Hopkins, has served as petroleum geologist in private exploration, on the Maryland and United States geological surveys, and as assistant professor of geology at the Colorado School of Mines and the University of Rochester. He is now associate professor at the latter institution. In 1924 he was a member of the Ellsworth Expedition to Peru and Brazil which made a detailed cross section of the Andes.

Miss Bradley is a graduate assistant in the department of geology and geography at Southern Methodist University, where she received her B.Sc. degree. She was a graduate assistant at the University of Nebraska in 1937–38, and received her M.A. degree from that university in 1938. This study of the Gulf Coast Salt Dome Area is part of her Master's thesis.

Dr. Putnam, native of Nova Scotia and graduate of the Nova Scotia Agricultural College, received his Ph.D. from the University of Toronto in 1935. He has done considerable field work and research in the province of Nova Scotia, and also in Ontario as fellow in agriculture at Ontario Research Foundation. He is on the staff of the department of geography at the University of Toronto. His article "Farm Distribution in Nova Scotia" appeared in the January, 1939, ECONOMIC GEOGRAPHY.

Dr. Zink, instructor in geography at the State Teachers College, Indiana, Pennsylvania, received her Ph.D. from the University of Chicago. She is author of a number of publications dealing with geography and related subjects.

Copyright 1939
by Clark University, Worcester, Massachusetts

(Indexes of ECONOMIC GEOGRAPHY *are issued every October for the volume just completed. The articles of the magazine are also indexed in the International Index to Periodicals to be found in every United States Library.*

Subscribers are requested to send notices of change of address five weeks before they are to take effect. Failure to send such notice will result in the incorrect forwarding of the next copy and delay in its receipt. Old and new addresses must also be given.

ECONOMIC GEOGRAPHY

CONTENTS FOR OCTOBER, 1939

EL-'IRAQ 325
HANS H. BOESCH

EVOLUTION OF SHIPBUILDING IN SOUTHEASTERN MASSACHUSETTS 362
PAUL HUFFINGTON AND J. NELSON CLIFFORD

BARROW IN FURNESS: A POPULATION STUDY 379
T. H. BAINBRIDGE

EUROPE'S FUEL AND METAL DEPOSITS EVALUATED 384
QUENTIN D. SINGEWALD

THE PETROLEUM INDUSTRY OF THE GULF COAST SALT DOME AREA . . . 395
VIRGINIA BRADLEY

AGRICULTURAL DEVELOPMENT OF NEW BRUNSWICK 408
D. F. PUTNAM

DRY-FARMING REGIONS IN UTAH 421
NORAH E. ZINK

BOOK REVIEW 432

ECONOMIC GEOGRAPHY

Published Quarterly by

CLARK UNIVERSITY, at 44 Portland Street, Worcester, Mass.

Editorial Office, Clark University, Worcester, Massachusetts

PRICE, $1.50 THE CURRENT NUMBER FIVE DOLLARS A YEAR
(except to charter subscribers)

Entered as second class matter at the Post Office at Worcester, Mass.,
under the Act of August 24, 1912

Copyright, 1939
by
Clark University
Worcester, Massachusetts

SHIPBUILDING

EVERY people that fronts upon the sea and feels the lure of its broad horizons, the challenge of its surging tides, the mystery of its manifold moods, is irresistibly impelled to explore its borders, to sail its apparently unbounded expanses, to reap the harvest that comes from its deeps, or that its shores provide. Every people in whose ears the call of the sea is ever sounding, before whose eyes the moody horizon changes aspect and form with every wind, upon whose lips the savor of salt is ever sharp, will turn to shipbuilding as inevitably as the husbandman turns to shaping his plow and reaper.

Thus upon every coast where fisheries or trade or travel or adventure engage the fancy of the folk, shipbuilding becomes an art, an industry of first rank. Wherever there are harbors to shelter the ships from storm, wherever there are shoals of fish or schools of whale to yield rich reward for hazard and effort, wherever there is trade to enrich life and enlarge desire, wherever there is hope of gaining comfort or profit or power from the sea, there shipbuilding flourishes.

And thus along the rigorous coast of New England from the time of the first settlement to our day, shipbuilding for fisherman, for tradesman, for traveler, for explorer, for imperialist, for pleasure-seeker, has gone on almost without pause. The ships built in its yards have sailed the seven seas, have borne the goods and folk of America to China and India, to Portugal and Algiers, to Arabia and Australia, to every nook and corner of the world.

ECONOMIC GEOGRAPHY

VOL. 15 OCTOBER, 1939 No. 4

EL-'IRAQ

Hans H. Boesch

THE kingdom of el-'Iraq includes more than el-'Iraq arabi proper, that is, the part of Mesopotamia below Baghdad (the old Babylonia). It embraces a large belt of the northwest-Arabian desert es-Shamiya west of the Euphrates, and extends from its capital Baghdad far to the north to include upper Mesopotamia or al Jazira, as the country between Euphrates and Tigris is commonly called (i.e. "the island"), as well as the greater part of the old Assyrian empire, the Kurdistan of today or, in the local language, simply al Jebel. El-'Iraq arabi, es-Shamiya, al Jazira, and al Jebel are four distinct building stones of the kingdom; each division has its own characteristics, problems, and possibilities. The country as a whole is many-sided in its geographic and economic aspects.

A name better known among geographers for the whole country, and also used during the first years of the British mandate, is Mesopotamia; it is however a foreign name and never used in the country itself. El-'Iraq arabi (i.e. "the 'Iraq of the Arabs"), or shortly mostly el-'Iraq, stands in antithesis to el-'Iraq Adjami (i.e. "the 'Iraq of the foreigners"), which designates geographically parts of western Iran and the Kurdish mountains and is politically today the name of a western Iranian province.

The state is still young. Its boundaries were partially established only within the last few years; censuses were taken at different times but have more the character and value of good estimates; most statistical data—if at all available and existing—are not dependable or adequate. The difficulties are best shown by the fact that the Yearbook of the International Institute of Agriculture (Rome) gives the area as being 371,000 qkm, while the Statistical Yearbook of the League of Nations as well as the Statesman's Yearbook give 302,000 qkm. The latter figure is accepted for this article. Good topographic maps exist for the more important sections of the country, but are not available, a great handicap with regard to studies in physiography and land utilization. An economic and geographic study is therefore faced by serious difficulties, if first-hand field observations are based upon a more general foundation. Nevertheless the author has tried to give a brief, but as complete account as possible of this country, which through its various divisions offers a striking example of Near and Middle Eastern conditions and the economic and social structure of the Orient in general.

No comprehensive geographic description has been written since Banse wrote his famous book "Die Türkei" (2d edition) in 1916; but a great number of excellent publications covering almost all the various fields have since been published, mostly in English; furthermore, admirable French studies in the Levant States form a valuable contribution.

In the first part of the article the physical setting (physiography, climate, etc.) will be described, while the second part is entirely devoted to the pattern and character of human occupancy, its influence, and its possible development in the future.

GEOLOGY AND PHYSIOGRAPHY

The ancient massive Arabian block, structurally an element of the great southern Indo-African continent, moved northward in geologically recent times and raised before it the tertiary belt of highly folded Kurdish-Armenian mountains. During advance the rigid Arabian block fractured along definite lines of weakness, and initiated the extended system of the Syrian-Palestinian and Red Sea rift valleys; great areas were covered with basaltic lava outflows, far into historical times.

In a northern marginal belt toward the mountain chains the sedimentary cover of the Arabian block was also folded into structures paralleling the high mountains as a piedmont zone, which constitutes the main zone of oil reservoirs in the Near and Middle East.

Coincident with, and subsequent to, the formation of the Kurdish-Armenian mountains, a broad zone with a sinking tendency developed along their outer, southern margin—the Mesopotamian trough, the youngest structural element, which continues eastward in the Persian Gulf and in the Indus-Ganges lowland, while westward its extension is crossed and effaced by even younger structural lines beyond the Syrian saddle. In the Iraqi section the filling up of the Mesopotamian trough began in its higher northern part in middle Tertiary (Miocene) time, while the central part was filled up in Quarternary time; in the southernmost part the advance of the delta has been noticeable in historical time.

Structurally the following units have therefore to be distinguished (Figure 1):

1. The Arabian block (es-Shamiya).
2. The Mesopotamian trough:
   a. Miocene division (al Jazira).
   b. Alluvial division (el-'Iraq arabi).
   c. Persian Gulf division.
3. The Tertiary mountain chains (al Jebel).
   a. Piedmont (marginal belt of Arabian block).
   b. Central zone of high mountains.

The Arabian block—Mesozoic and Tertiary sediments of a pronounced shelf facies were deposited on the old crystalline base each time the sea advanced and covered part of Arabia. Thin bedded cherty limestones, white chalky reefs, and interbedded marls determine the character of the landscape over vast areas, bare of any vegetation. Occasionally sandstone horizons, marking the base of each cycle of marine transgression, change the monotonous colors and give rise to different belts and patches of sandy desert. Toward the Mesopotamian trough the beds dip gently from a central nucleus (Jebel 'Aneiza) for vast distances; in the north the shore line of the old Miocene filling, and in the south a conspicuous escarpment, mark the boundary toward the different divisions of the Mesopotamian trough. No structural folds, except perhaps in the outermost belt, are re-

ported; the extended Palmyrian folds hardly enter Iraqi territory, and lava outflows are entirely restricted to the Syrian portion of northwestern Arabia.

The Iraqi portion of northwestern Arabia, with which this paper is primarily concerned, is a wide stony plain, strewn with dark chert pebbles and chips; sandy patches intervene but rarely. The flat or gently undulating

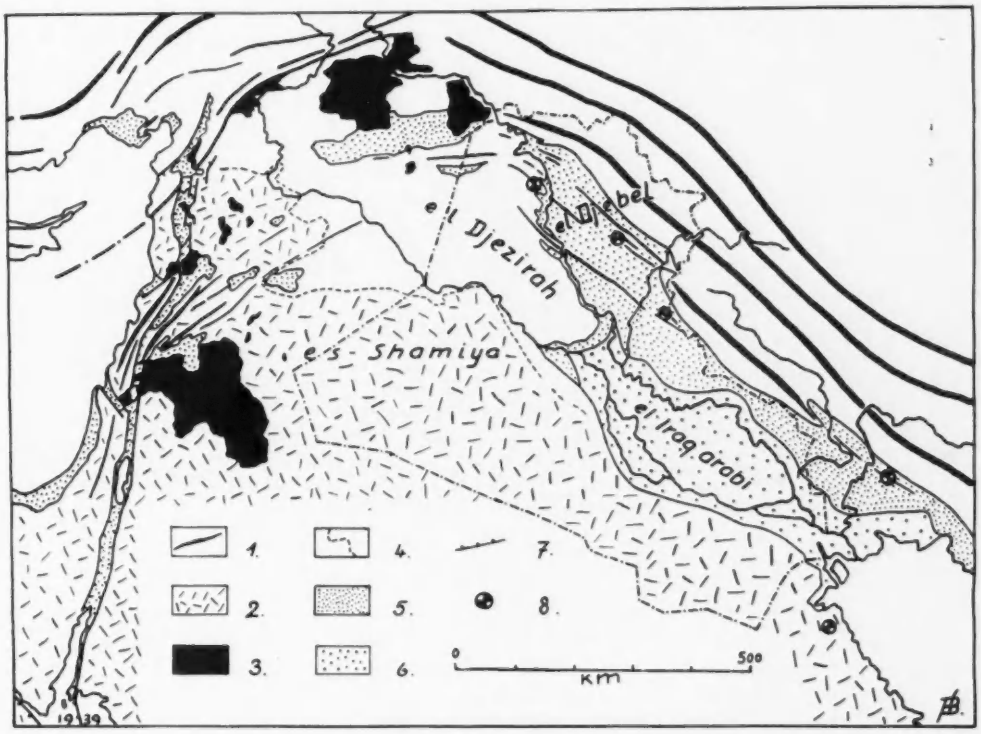

FIGURE 1.—Geology and physiography. 1. Tertiary folds. 2. Arabian block, not covered by Miocene deposits. 3. Outflows of basaltic lava. 4. Miocene filling of Mesopotamian trough. 5. Quarternary gravels and outwash material in general. 6. Alluvial deposits of el-'Iraq arabi. 7. Principal fault lines. 8. Main centers of oil production.

different plains represent several peneplain levels, mostly of early and middle Tertiary age. Only along their zones of contact or intersections is the monotony of the flat country broken, where hills of 50 to 100 feet already represent outstanding land marks. Since Tertiary time a ramified system of wadis has developed on the more central elevated parts of the country, and has since, following the receding shore line, extended into the outer portions; the longest of these wadis is perhaps W. Hauran, over 350 km (220 mi.) in length. The wadis are deep-cut cañons (100 to 150 feet deep in es-Shamiya) in limestone areas, but broad valleys in the marlier parts; the prevalent arid conditions and the temporary but torrential discharge of water through them at intervals, have led to a longitudinal and latitudinal valley-profile, and to deposition of gravel beds etc., which can definitely be distinguished from those developed under humid conditions. It is noticeable that even the older sections of the wadis, i.e. the upper, more central parts, developed in Pleistocene and late Tertiary time, seem to show the characteristics of the arid cycle, a fact to which

we shall return by discussion of climatic conditions in prehistoric times.

Within reach of the ramified wadis the landscape in many places seems wild and almost mountainous; but at the peneplain level, all relief, which after all has only the character of a stream pattern slightly engraved in a big plain, is effaced and a monotonous flatness extends to the far-away horizon.

From a bird's-eye view the picture regains character, for the peneplain surfaces obviously dip away from the Jebel 'Aneiza (3,084 feet) towards the Mesopotamian trough and to the Euphrates. The Euphrates enters el-'Iraq shortly below Abou Kemal (580 feet) and flows for over 250 km (155 miles) first west-east through a broad valley and then north-south through a cañon 300 to 500 feet deep, following in general the geologic boundary between the Arabian block and the Mesopotamian trough, until the river reaches alluvial Mesopotamia at Hit (at Ramadi, 140 feet). The course of the Euphrates marks here the boundary between the Shamiya and Jazira.

FIGURE 2.—W. Agara Muyat. North of Rutba, 30 miles. Into an older peneplain the wadi is cut about 100 feet deep; it drains into the Euphrates (north) crossing on its way the great Ga'ara depression. The track made by the author's party is clearly shown in the left foreground.

Within the area dissected by wadis soil erosion during the rainy winter season is considerable, and no soil profile has had time to develop; but on the peneplain surfaces a well developed soil profile has formed; accumulation of calcium carbonate in the form of a thick layer with vertical structure close to the surface is typical. Due to scarce and only temporary vegetation the soil is of a gray to light brown color. Here again it should be noted, that on these ancient peneplains no traces of a former humid climate can be found in the formation of the soils; the soil profile is throughout typical for arid and semi-arid conditions.

The Mesopotamian trough—Al Jazira, the northern portion of the trough filled up in Miocene time, is in many instances similar to the Shamiya; looking over the wide cañon of the Euphrates between Hit and Ana, there seems to be only one wide plain. In the region of the Syrian saddle too, the two physiographic provinces merge into one another. It is therefore necessary to point out the differences.

The Miocene gypsum and salt formation, well known all over the Orient, is covered by a sandy gypsiferous soil, easily recognizable through its peculiar stand of vegetation in spring. Leaching and swelling of the gypsum calls forth a local topography, with which there is nothing comparable beyond the Euphrates. Instead of the broad pene-

plain surfaces a greatly undulating gypsum landscape, with broad undeveloped drainage zones in between, characterizes the region.

The most important drainage complex is the Wadi Tharthar, a partly perennial watercourse, reaching from Jebel Sinjar close to 325 km (200 miles) southward, where it ends and disappears in a salt marsh.

In a similar way as the Shamiya, the Jazira rises above alluvial Mesopotamia from which it is separated by a distinct escarpment. The cliffs, delimiting el-'Iraq arabi in the west and north should, according to certain investigators, represent the shore line of the Quarternary extension of the Persian Gulf. According to some the cliff (i.e. "el-'Iraq") has also given rise to the name of the country.

The Miocene of al Jazira has also been slightly folded, but more so in Syria than in el-'Iraq, where the folding is almost imperceptible from the ground. Al Jazira extends to the north far beyond the Iraqi boundary through Syria into Turkey. In the northern division of al Jazira the character of the country changes and is similar to the piedmont and the outer chains of the Kurdish mountains. The country around Diyarbekir where the folding is strongly developed is still within the northern Jazira.

El-'Iraq arabi, alluvial Mesopotamia, is actually old Babylonia, though different in appearance from the traditional "cradle of mankind." Its extensive plain represents the alluvial filling of the trough, a process which is still going on by the Euphrates, the Tigris, and various rivers from the Zagros Mountains. The Euphrates falls only 140 feet from Ramadi, the Tigris 115 feet from Baghdad, until after a course of approximately 800 km (500 miles) they attain the Persian Gulf as Shatt-al-Arab. On this long

FIGURE 3.—W. Al Quaim. The Euphrates lies a few miles north behind the hill crossed by the wadi. The influence of the bedrock and the river bends upon the latitudinal valley profile is clearly shown. Very sparse vegetation due to the absence of a soil cover. Dulaim Bedouins in the foreground.

way the rivers have built up their own courses and obstructions with silt in suspension, the rivers in places flowing higher than the surrounding country. Without flood control they would easily breach their levees during the main flood and inundate large areas, as happens almost every year. A greater part of el-'Iraq arabi is consequently composed of salty marshes, desert, and steppe, and only small belts of arable land along the main river arms become evident by their green color. The Euphrates and the Tigris actually deposit most of their silt in the marshes of Babylonia, the major factor of growth in the growing delta coming from the Karun.

The coastal area may well be called amphibian in some instances for tidal inundations from the gulf reach as far up as Basra. It has been calculated that spring tides can raise the water level up to 8½ or 9 feet; the effect of southeasterly gales, frequent from October to April, may produce a further increase of 2 to 2½ feet. If at the same time extreme flood of the rivers should be checked by such unusual combined tidal inundations, a submergence may at one time have resulted that persisted in the memory of mankind as the "Great Flood."

The Persian Gulf is the very shallow

extension of the Mesopotamian trough in an easterly direction; the greatest depth is 252 feet. The entrance to the Shatt-al-Arab was not navigable for larger sea going vessels until expensive dredging was undertaken.

The tertiary mountain chains—Abruptly emerging from the plain of al Jazira is the long front range of Jebel Makhul and Jebel Hamrin; beyond, toward the high mountains, succeeds the piedmont district made up of parallel folded ranges, separated by broad intermediate plains filled with the outwash material from the high mountains. In the greater part of el-'Iraq, the strike is northwestern, but in the Mosul area, according to the change in the high mountains, they swing to the west-southwest, Jebel Sinjar pointing in that direction. Folded chains and gravelly plains rise gradually towards the mountains; the rivers—Great Zab and Little Zab are the best known—have eroded wide valleys and finally reach the Tigris. Within this folded belt lies the northern oil zone.

As abruptly as the first front ranges of the piedmont district emerge from the Jazira, so abruptly rise the outer chains of the high Kurdish mountains out of the last piedmont plain. Chain beyond chain, with increasing intensity of folding, imposing mountains of limestone, they rise 6,000 to 8,000 feet in the southwest, and attain 10,000 feet in the inner northeast. Broad longitudinal valleys and basins are interconnected through gaps, gorges, or high passes. The youth of the mountain belt is demonstrated by the fact that the anticlines still form the high chains, and the synclines the longitudinal valleys.

FIGURE 4.—W. Al Quaim. This is the same location as Figure 3. Occasional flood water rushing through the wadi has washed out a deep hollow in the massive limestone. The gorges approximately 60 to 80 feet deep with perpendicular walls and over 500 feet long. Such undulations in the longitudinal valley profile are typical for the arid cycle.

WEATHER AND CLIMATE

A study of the climate of el-'Iraq has still to be based on the observations of a very few stations, primarily Mosul, Baghdad, Babylon, and Basra. Additional observations were also carried out at the sites of the principal excavation camps, as e.g. at Ashur, but these only over short periods. Due to the great annual variability of rainfall they are representative only for the weather of some particular year or brief period of years, and have to be disregarded for climatological research. At all of its trans-desert pumping stations the Iraq Petroleum Company takes three daily readings; unfortunately their data, which would give a continuous double chain from the Mediterranean across northwestern Arabia to the Kurdish mountains, were not yet available. It seems likely that elsewhere in the country other meteorological observations have been recorded; however they are not published and cannot come to the notice of anyone

outside the country. On the other hand the French mandatory government in the Levant States has fortunately established a meteorological service extending over the whole country, the data of which are published in the *Revue de géographie physique* (Vol. VI; Paris, 1933) in a most valuable summary.

The main scope of this section therefore serves to reëxamine the old observations in the light of new meteorological studies in the surrounding states. Notes taken during the author's stay in 1937–38 and information from various sources while in the country aided considerably. Distribution of the natural vegetation and the various types of land utilization, observation of typical soil profiles, etc. have also been employed to refine the map of precipitation of el-'Iraq in particular.

This section—as so much else in this study—has therefore to be preliminary; new data will permit a more accurate map and a clearer understanding of the controlling climatological processes. With the agricultural problems of the country in view, regular observations over the whole country, including the mountain district, should be extended and emphasized, and the material obtained from them should be fully organized and published.

In the most general way, various climatic provinces of el-'Iraq may be compared with the climate of the eastern Mediterranean; the summer is warm and hot and without precipitation; the southward shift of the belt of westerly cyclonic storms brings precipitation during the winter from the Mediterranean to Mesopotamia across the broad gaps in the Levantine coastal range and the Syrian and northwest Arabian desert. In Syria the succession of climatic provinces from the coast over the Lebanon and the Anti-Lebanon into the desert has been carefully studied, the "type syrien subdésertique" and the "type saharien" occupying the area extending towards and into el-'Iraq. The climatic provinces of el-'Iraq have therefore already been defined as being "mediterranean, but of a distorted and exaggerated type, due to the generally very scanty and absolutely seasonal precipitation, and the continental character of temperatures."

There are, however, a few,—but

FIGURE 5.—Rawa on the Euphrates. Rawa-Ana, a little country town with several thousand people and an old Turkish castle, lies at the point where the Euphrates is cutting its bed as a deep cañon into the desert plain. The irrigated land, wheat fields in the foregronnd and date trees across the river, is restricted to the small river terraces. In the foreground is shown a water-wheel with irrigation canals. Gully erosion from the river level is gradually destroying the fields.

FIGURE 6.—Road to Kurdistan between Erbil and Shaqlawa. Entrance to one of the transverse valleys cutting across a syncline. Fields cleared from stones occupy the talus and river terrace in the foreground; the hills are used for pastures. This, together with the making of charcoal, has reduced the forests to the few oak trees dotting the limestone ridges; soil erosion has made reforestation a problem almost impossible to solve. The macadam road leads to Ruwandiz and thence to Iran.

decisive—factors in shaping the climatic provinces which have little or no influence in the eastern Mediterranean:

The chain of the Armenian and Kurdish mountains intercepts the westerly winds, which principally from October until May cross the Syrian saddle from the Mediterranean, causing increased precipitation all along the piedmont zone, to form the famous fertile crescent, a great semicircle about the northwest Arabian desert, with a southern inner belt of pastures for the desert nomads and a northern outer belt, where agriculture prevails. Here lie the piedmont towns Alep-Urfa-Diyarbekir-Mosul-Erbil-Kirkuk, and the much famed piedmont routes connecting East and West since ancient times, in times of political insecurity more under the protection of the first mountain ranges, otherwise attempting the open steppe and even the desert. Towards the south, in southern Kurdistan and in the Zagros Mountains, the amount of precipitation is greatly reduced in the piedmont as well as in the mountains, and does not suffice for dependence of farming upon rainfall. Kirkuk roughly marks the southernmost point of the fertile crescent. The continental character of temperatures in the whole of el-'Iraq is mainly due to the extended and generally elevated land mass of northwestern Arabia (1,500–3,000 feet); the equalizing effect of the Mediterranean Sea is felt no longer. Furthermore an extreme low pressure area over east central Arabia in summer, and an extension of the great central Asiatic high in winter, overlapping from Iran over the Kurdish mountains, have a decisive influence upon the climate. And finally the humid-hot climate of the Persian Gulf area is entirely different from any phase of Mediterranean climate.

The low pressure areas developing in spring as a result of increasing temperatures over the different land masses of the Near and Middle East converge and concentrate during June and until September, but often as late as October, into the great east-central Arabian low, as the westward extension of the Asiatic low pressure area, well known through the influence it has upon the southwest monsoon. Following the steep gradient from the Mediterranean and Asia Minor toward the low pressure area the "Etesian winds" from the northwest quadrant cross the high Levantine ranges and hence the Syrian desert before reaching el-'Iraq; in the northern part of el-'Iraq the summer winds do not come from the Mediterranean but from eastern Anatolia, and consequently develop along the northern piedmont to a local wind of "foehn" character. In this belt humidity is in all months of the year lower than in Mosul, Baghdad, and Basra, and only Babylon shows slightly lower humidity figures during a few months in summer. These never changing Etesian winds are therefore warm and dry, whether

they come from the Mediterranean or from Anatolia.

All of el-'Iraq receives no rain for several months during the year; a glowing sun shines day after day from a blue sky and kills the last traces of vegetation. The temperatures rise and become continental, the anomalies for summer temperatures being approximately +5° C. Except for irrigated patches el-'Iraq becomes a dusty, sun-baked desert, trembling under a glowing dusty mass of air; whirlwinds develop suddenly like explosions, and wander quietly like tall smoke towers through the desert. Only in the north, in the mountains and over the central parts of es-Shamiyah the temperatures drop physiologically noticeably during the night, while in Baghdad and Basra, even the nights are intolerably hot. Only the high mountains have a less extreme and very agreeable, but nevertheless dry, climate; places like Amadiya, Ruwandiz and Sulaimaniya may soon develop as summer resorts, while today the Levantine ranges and Cyprus are favored places thanks to the better accommodations they afford.

Only occasionally during the summer the wind changes, and hot and humid masses of air from the Persian Gulf blow as far up the plain as Baghdad and even farther north; the air is then quite hazy. Life is intolerable both day and night. This peculiar gulf climate is however generally restricted to the Basra-Khorramshahr area.

The central Asiatic high pressure area, located in October about north of the Caspian Sea, extends in November over the whole of the Iranian plateau, and in December overlaps the southern Iranian ranges into el-'Iraq and even northern Arabia, while at the same time the east central Arabian low gradually disappears. Also in October the belt of westerly cyclonic disturbances has shifted from middle Europe southward and lies approximately in the latitude of the Mediterranean. These cyclonic disturbances start in middle or late October to enter el-'Iraq either over the Syrian saddle or more from the southwest about along the southern branch of the pipe line from Palestine. Black clouds, electric storms, thunder and lightning without rainfall, and heavy rains that evaporate long before they reach the ground, long precede the first real rain, anxiously awaited by nomads and farmers; but once they come, the rains burst abruptly and heavily. The passing of a cyclonic storm over the wide open desert is an impressive spectacle.

Summer passes into winter without an autumn; the temperature drops rapidly, and precipitation increases with each new storm. The heavy rainfall, absorbed neither by vegetation nor soil, is collected in a few huge catchment basins and carried away in broad wadis, many times causing great destruction, damage, and death to man and beast in its lower reaches, and blocking all traffic for days.

In December and January the great extension of the central Asiatic high checks the eastward vagrancy of the cyclonic storms to some extent and leads to a remarkable variability of the weather in a broad zone along the mountains, i.e. in almost all of el-'Iraq. The cyclonic storms are no longer prevalent, but if they reach the country, they bring heavy snowfall to the northern area, now and then even south as far as Baghdad. Northeasterly winds from the central Asiatic high flow quietly from the mountains and bring long series of cold crisp days, with wonderfully clear view from the plains into the mountains; this is the typical winter weather. But often humid, relatively warm air from the Persian Gulf brings

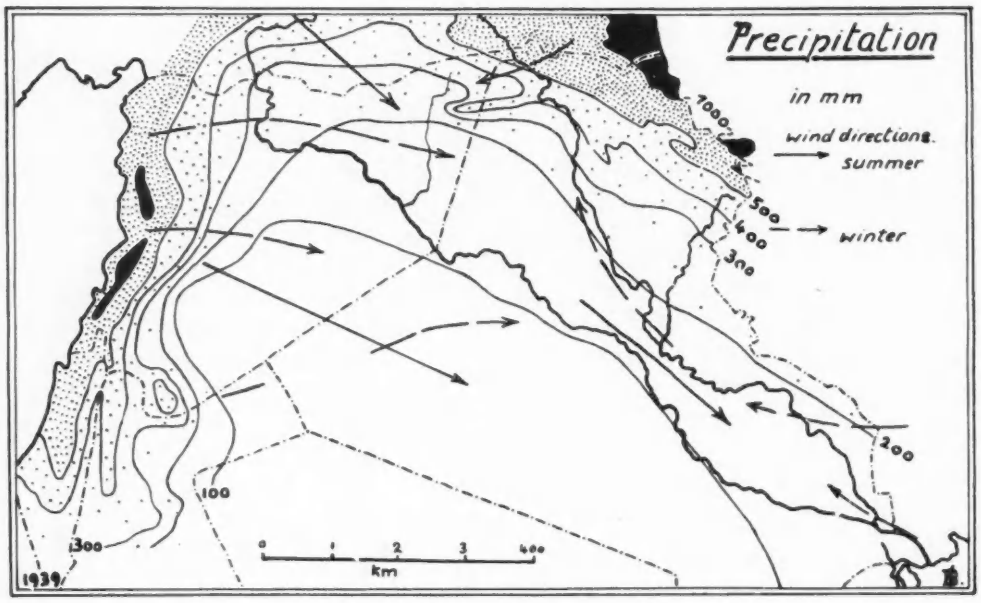

FIGURE 7.—Precipitation of the Near and Middle East.

a period of cloudy and rainy days even as far north as the Mosul area. Contrary to the short but heavy showers of the cyclonic storms, it rains continuously for days; the roads and the fields become impassable and the adobe buildings start to collapse. In the Shamiya and the Jazira, where there is absolutely less rainfall, the winters are for the greater part drier. Fine, cold snow falls, and a biting wind imposes great hardship upon nomads and their flocks.

It is not until February, with the recession of the central Asiatic high pressure area, that the Mediterranean cyclonic disturbances regain greater influence, now interrupted by long periods of warm sunny days, while the nights are still cool or cold. This is the spring weather of el-'Iraq, beautiful in the steppe country, where the green prairie with colorful red and yellow anemones, poppies and a multitude of other bloom is dotted with clear water ponds from the last rains. Pasture and water is plentiful for the herds and flocks of the nomads, and for the first time the melancholy songs sound happily over the open country, which in a few months becomes again a dusty, sterile desert. The late spring rains are of particular importance in the northern area, where they supply the water necessary for the filling of the wheat and barley.

The air pressure conditions are expressed by the double maximum of the precipitation curve in November and February-March in the northern area; in the southern area, where the rain probably derives mostly from the Persian Gulf and not from the Mediterranean, a double maximum can also be noticed, but in December-January and March; the February depression is probably caused by the maximal extension of the central Asiatic high and a consequent influx of cold dry air from the mountains.

Again the higher parts of the Kurdish mountains have a somewhat different climate, mainly because of their higher altitude; snow falls mainly after New Years; and until late in spring, when

the lowland is already changing to a brown desert, one can see from one of the hills in the vicinity of Mosul a northerly semicircle of snowy peaks in the far distance.

A series of climatic diagrams illustrates the climate of the different parts of the country. Mosul is representative for the northern piedmont, with regard to precipitation of its outer, drier belt; this is old Assyria, where farming by rainfall is possible, and consequently an evenly distributed population with a fairly high density can be supported. Because of lack of stations from Iraqi Kurdistan, Diyarbekir (Turkey) has been chosen as an example of the higher piedmont belt. Unfortunately no data exist for the Kurdish mountains proper (e.g. for Amadiya or Ruwandiz); for them the rainfall map is entirely preliminary. The Syrian-Arabian desert and steppe is represented by the Syrian station Deir-es-Zor, although this represents a more northern, less continental, type with higher rainfall figures, than in the typical Shamiya farther south.

Baghdad and Babylon represent the Babylonian climate of el-'Iraq arabi, where the rainfall is under no circumstances sufficient for farming; only the main rivers save the country from being desert and steppe; irrigation agriculture, and high density of population with intermediate unsettled areas are characteristics. Finally Basra illustrates the Gulf climate, although of a marginal type; the Iranian station of Bushire would be more typical.

The attached Syrian diagrams (Figure 8) permit comparisons between the

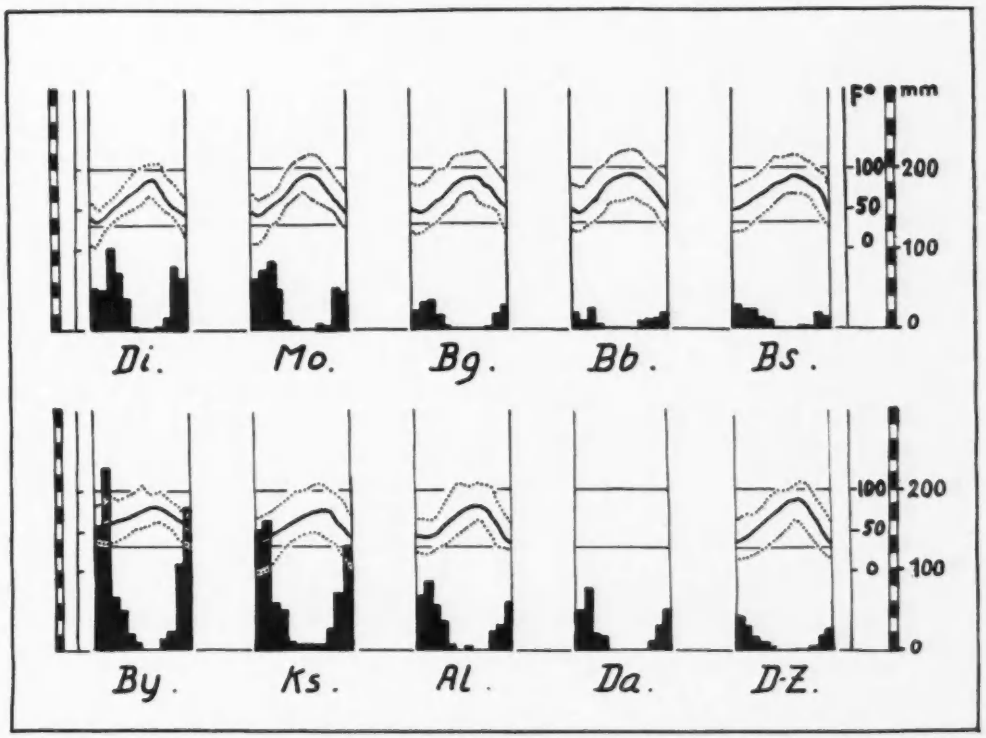

FIGURE 8.—Climatic diagrams. Di.—Diyarbekir. Mo.—Mosul. Bg.—Baghdad. Bb.—Babylon. Bs.—Basra. By.—Beyrouth. Ks.—Ksara. Al.—Alep. Da.—Damascus. D-Z.—Deir-es-Zor. The dotted lines indicate the curve of absolute minima and maxima of temperature. No temperature charts were available for Damascus.

FIGURE 9.—W. M'sath-ar-Rutba. Immediately south of Rutba police station. Shortly before the first rain falls the Amarat Aneze Bedouin tribes wander from their summer watering places in Rutba, Wadi Hauran and the Ga'ara to the Hammada country in the southwest, where the rain falls earlier and pasturage is favored by warmer winters. Typical vegetation of a wadi bottom at the end of the summer in the foreground (*artemisia*—camel thorn).

Assyrian, Babylonian, the Northwest Arabian, and the Gulf climate on one side and the succession of Eastern Mediterranean and Syrian climatic types on the other.

According to the Koeppen classification of climates, the Iraqi climatic provinces belong to the following types:

BW (desert climate, reduced rainfall less than 250 mm): Es-Shamiya and western el-'Iraq arabi.

BShs (steppe climate, reduced rainfall 250–500 mm, annual mean temperature greater than 18° C, dry period in summer): el-'Iraq arabi, al Jazira.

BShsp (id., rarely foggy, but high humidity and extreme summer temperature greater than 28° C): Coastal area.

Csa (warm temperate rainy climate, dry period in summer, mean temperature of warmest month greater than 22° C): al Jebel (inner piedmont and mountains).

According to our more detailed classification the Csa would, in general, be represented by the Kurdish and Assyrian types; the BShs by the "type syrien subdésertique" in the north and the Babylonian type in the south, according to the different influence from the Mediterranean and the Persian Gulf respectively, resulting in a somewhat different distribution of rainfall; the BShsp by the Persian Gulf climate; and the BW by the northwest Arabian type or "climat désertique, type saharien."

The region of the Near and Middle East has been a welcome field to test the theory of climatic changes and their influence upon history. The point cannot fully be argued here—a much more complete presentation and discussion of facts would be necessary—; only this much seems to be certain, that at least in historical times, i.e. about since 2000 B.C. any climatic changes must have been negligible with regard to their influence upon historical development.

Roman projects in the midst of desert and steppe had to solve the same problems of securing and storing water as today; this has been proved in detailed manner for Palmyra and will un-

TABLE I

METEOROLOGICAL DATA FOR FIVE MESOPOTAMIAN STATIONS

	Diyarbekir	*Mosul*	*Baghdad*	*Babylon*	*Basra*
Temperatures:					
Mean ann. temp. F°	60.8	68.2	71.3	73.3	73.1
Id., C.°	(16.0)	(20.1)	(21.7)	(23.0)	(22.8)
Abs. max. temp. F°	107.8	118.8	121.0	121.3	114.4
Abs. min. temp. F°	−0.4	4.3	18.6	18.9	23.7
Precipitation:					
Mean ann. precip. inches	19.24	16.18	6.95	4.25	6.23
Id., mm	(489)	(411)	(176)	(108)	(158)

After: I.D. 1,117, H.M.S.O., London—The climate of the Eastern Mediterranean and adjacent countries.

doubtedly be proved in the future for other sites. Reports by commanders of the Roman expeditionary forces (e.g. Aelius Gallus a few years B.C.) as well as Xenophon's description of the crossing from Alep to Baghdad by the Greek army 401 B.C., might be repeated in a description of the country today. It should be remembered that in Roman times the Near East was a flourishing colony with an extension of the settled area farther than ever attained later, and when the country was allowed to retrogress, it was not as a result of climatic changes. The evidences of another flourishing period, the Babylonian, have not yet been so carefully examined from this point of view; it goes however a long way in demonstrating a great stability of the climate, if today essentially the same building material is used as in those ancient days; for example adobe constructions are not advisable under the climatic conditions of northern el-'Iraq today, as has been shown earlier in this article. All over the steppe country traces of Roman and older occupation, such as roads and camping grounds, are well preserved; they are however impossible to observe from the ground but air surveying within the last years has brought proof enough. Only in a continuously arid or semi-arid climate can such slight traces be so well preserved through centuries.

Climatic changes, for these and many more reasons must be discarded as explanation of the fluctuations of oriental power and influence. They are better explained by the rôle el-'Iraq, together with other countries, still plays as a marginal country in its relation to desert Arabia. From southern and outheastern Arabia, a settled country with agriculture, tribes in all historical times have had to emigrate into the wide open plains of inner desert Arabia, either because of wars, pests, or famine, or around A.D. 450 even because of the collapse of the famous dam of Mareb with consequent destruction of all the farm land. Shifting to inner Arabia, they adopted by necessity the life of the nomads; however in course of history they tended towards the northern marginal belt, and periodically under the pressure from the south, forced their ways into the surrounding lowlands and there in time were partially led back to farming. This is the history of Arabia as far back as historical records go. For many tribes such successive stages can be demonstrated, while they are very likely for others; the history of the marginal Near and Middle Eastern countries is closely linked up with that of Arabia: First the pressure of the desert tribes endangered trans-desert arteries of trade and commerce, that weakened the position of the surrounding states and finally ended a long period of flourishing culture. Babylonia, and more so Assyria, had to fight against the desert tribes in the same way as modern powers must. The fact that essentially the same problems were existent during all periods of history is in itself an evidence for relative climatic stability, as the social and economic status of these antagonistic groups was primarily based upon climatic factors and consequences.

It is however still an open question, whether the same is true for prehistoric times. Earlier in this article it has been pointed out that the characteristics of the wadis and the peneplane soils of the Shamiya make it seem likely that the pleistocene humid climate of the Mediterranean—corresponding with the glacial period of Europe and North America—did not extend into northwestern Arabia. Except for the upper extension of the Persian Gulf the general distribution of water, mountains, and

land masses must have been approximately the same then as today. Even postulating the existence of a more humid climate in the Eastern Mediterranean, this does not necessarily prove the same for the inner part of the country, which has ever endured the same climatic conditions as today, i.e. westerly winds in winter and northwesterly in summer; and even a double rainfall and generally lowered temperatures would not change essentially the climatic effects in the Shamiya and Jazira, though it might naturally have a strong effect in the piedmont and the mountains. This seems to have been the case, according to a well developed system of gravel terraces along the Euphrates and Tigris. But before anything more definite can be said on this point, detailed studies of Quarternary geology and physiography must be carried out in all the different sections of the country.

Hydrologic conditions in el-'Iraq are closely connected with climate. In the Shamiya all the drainage lines are developed as wadis, of which the character has already been described. In the Jazira only the Wadi Tharthar could be described as semiperennial; in years of heavier rainfall there is locally enough water, although perhaps in many places only ground water, for the subsistence of the nomads along its middle course. Only the rivers which head partially or wholly within the Armenian and Kurdish mountains are actually perennial. The piedmont area is well supplied in its northern and southern portion, while the Mesopotamian lowland proper is drained and irrigated only by the two great rivers of the country, the Euphrates, i.e. "the very broad one," the longest river of western Asia, and the Tigris, i.e. "the narrow." Since the problems of irrigation in particular are discussed in detail elsewhere later in this paper, only a few additional data are given in Table II.

Low water in summer results mainly from complete lack of precipitation in the greater part of the drainage area; with the beginning of winter-rains the water rises slightly, but the great flood does not come until the snow melts in the mountains. Thanks to the shorter course of the Tigris as compared with the Euphrates the flood arrives in Baghdad generally about one week or more earlier than in Hit. The sources of Euphrates water are mainly within the Armenian mountains; on its long middle course across the Syrian desert, the river loses more water through evaporation and irrigation than it re-

TABLE II

IRRIGATION DATA

	Euphrates	*Tigris*
Measurements refer to	Hit	Baghdad
Length of river	2,775 km*	1,950 km
Drainage area	673,000 qkm	375,000 qkm
Mean annual discharge	1,095 cm/sc	1,180 cm/sc
Mean max. flood	2,750 cm/sc	3,000 cm/sc
Mean low water	400 cm/sc	300 cm/sc
Abs. max. flood	5,300 cm/sc	7,000 cm/sc (Mosul)
Months of flood	(March)-April-(May)	
Months of low water	October	
Figures for the Nile: Mean ann. discharge at Kairo		2,300 cm/sc
Id., at Wadi Halfa		3,413 cm/sc
Months of Flood		September-October
Months of low water		April-May

*Armenian Taurus Mts.—Hit (Syrian desert) 1,200 km; Hit—Gurma Ali (until 1908 at Qurna; confluence with Tigris) 890 km; Shatt-al-Arab (Gurma Ali-Fao) 150 km.

ceives from the Balikh and Khabour. Not so the Tigris; after entering the lowland in the Tur Abdin area it collects all the piedmont rivers from the Kurdish Mountains, namely the eastern Khabour, the Great and the Little Zab and the Diyala, which resemble the main stream with regard to the distribution of low water and flood. The course of the Euphrates is similar to that of the Nile; it presents hydrologically quite a different aspect from the feather-like network of the Tigris and its tributaries.

According to the climatic provinces two quite different divisions of natural vegetation develop: (1) in the northern mountains and partially also in the piedmont chains rainfall is sufficient for thin forests consisting mainly of oak trees, followed by meadows above 4,000 or 5,000 feet; (2) but in the rest of el-'Iraq the continentality of the temperature and the strictly seasonal and scanty rainfall result in complete absence of trees and annual change from steppe in spring to desert in summer.

In spring a great number of grasses and flowers grow over the whole country, as a tall-grass prairie in the piedmont belt, and a bunch-grass cover in the southern part of the country and in the Shamiya; such ephemeral plants show no adaptation to the climatic conditions, for their brief existence is completed within the few months of favorable conditions. With rising temperature and reduced rainfall the grass cover withers rapidly; except for the fertile crescent, vegetation is restricted almost exclusively to the wadi bottom during summer. From a small shrub in spring the camel thorn (Artemisia) grows here to a height of 3 and more feet. Only a careful study of plant communities could furnish an accurate definition of the boundaries between grass-steppe and desert; in this country shrub steppe constitutes no distinct formation but is more a locally restricted type of desert vegetation. In a general way the boundary follows the line of 200 mm for the desert, 300 to 400 mm being the main steppe area, and above 500 mm the forest area. A sure sign of desert conditions is also date cultivation on a commercial scale. In addition to the main types of natural vegetation there are local variations along the perennial rivers, around the salt marshes and regularly inundated areas, and in the coastal district.

FIGURE 10.—Euphrates valley, above police station An-Nahiye. Disused farm land which could easily be watered, if water wheels or lifts were restored. Spring rains and warm days produce a varied flora; the Bedouins know how to use herbs, flowers, and mushrooms. Here Dulaim Bedouins and the author's driver are collecting camomile for tea and medicinal use.

NATURAL DIVISIONS

Based upon natural factors as well as types of land utilization the following division of el-'Iraq has been made (see Fig. 11):

I. Al Jebel:	a. High Kurdish mountains.
	b'. Northern piedmont area.
	b''. Southern piedmont area.
	c. Jebel Sinjar area.
	d. Jebel Makhul-Hamrin area.
II. Al Jazira:	a. Al Jazira proper.
	b. Middle Tigris area.
	c. Middle Euphrates area.

III. El-'Iraq arabi:
- a. Desert and steppe of Zagros piedmont.
- b. Northern Babylonia and Diyala area.
- c. Babylonia, along Euphrates.
- d'. Babylonian steppe, marshes etc.
- d''. Steppe, marshes etc. of al Batihah.
- e. Babylonia, along Tigris.
- f. Shatt-al-Hai area.
- g. Lower delta area.

IV. Es-Shamiya:
- a. Northern area.
- b. Southern area.

The important rôle el-'Iraq is again playing in world politics and economics is but the latest phase in a series of periods of power and influence, of times when the organized state together with its whole economic and social structure lapsed into decay under pressure of the nomad tribes of central Arabia. El-'Iraq thus shares the same fate of a marginal state as others in the Near and Middle East, which show historical alternations between the organized state, with its officials representing the written law, its development of irrigation, agriculture, and trade routes across steppe and desert, and long periods of tribal law and tradition imposed upon the wide country, which endangered arteries of commerce and trade, and restricted the formerly flourishing country to relatively small and unimportant territory.

From the decay of the caliphate up to the World War, wild Bedouin tribes roamed the wide northwest Arabian desert and steppe, and were practically masters of the country. The sphere of influence of the Ottoman officials was restricted to the few cities and the more densely populated parts of the agricultural land. Plans for attaching the nomad population to certain areas, of developing irrigation programs, etc. never developed further than the initial stages. El-'Iraq was a true Turkish province.

The fundamental change came through, and after, the World War, when—first stimulated by British authorities—the Arabs took charge of their own affairs. Today central Arabia has ceased to be a threatening danger to the marginal states; instead it has become a nucleus of their national, racial, and religious ideas. For the first time since Mohammed, central Arabia itself became an organized state (Saudi Arabia) under Ibn Saud; and if today nomad tribes following old tradition extend their activities into the surrounding country, the incident is settled by diplomatic steps and has no more the significance of perilous pressure upon the marginal states it once had.

In international politics el-'Iraq resumed an important rôle shortly before the World War. Industrialized Germany extended her influence along the "Balkan axis" as far as the Middle East. Misinterpretation of geographic conditions led to the belief, that el-'Iraq was primarily a country for future promising colonization; the well known "Baghdad-Bahn" was to be the connecting link between industrial production at one terminus, and agricultural at the other.

The World War put a definite stop to German plans. Long military operations have given much better information of the country and its population, and clearly demonstrated how little it qualifies as a place for future colonization. Only the zionist movement has again, but unsuccessfully, taken up the old plans. British, French, and American (the Chester concessions) interests were represented, when the victorious powers decided upon the fate of the old Turkish provinces and announced their demands. All three were primarily interested in the exploitation of natural resources, i.e. the oil deposits of the Near and Middle East. France, at the time the most powerful Mediterranean power, also claimed Syria as a mandated terri-

FIGURE 11.—I. Al Jebel: a. high Kurdish mountains; b'. northern piedmont area; b''. southern piedmont area; c. Jebel Sinjar area; d. Jebel Makhul-Hamrin area. II. Al Jazira: a. al Jazira proper; b. middle Tigris area; c. middle Euphrates area. III. El-'Iraq arabi: a. desert and steppe of Zagros piedmont; b. northern Babylonia and Diyala area; e. Babylonia, along Euphrates; d'; Babylonian steppe, marshes etc.; d''. steppe, marshes etc. of al Batihah; e. Babylonia, along Tigris. f. Shatt-al-Hai area; g. lower delta area. IV. Es-Shamiya: a. northern area; b. southern area.

tory to extend and to strengthen her influence in the eastern Mediterranean. Great Britain had territorial interests in the Orient to secure her land route to India, later developed into the most important air route from the west to the east. But territorial occupation was also mainly to guarantee the granting of concessions of the oil fields, and to make construction work possible. Beyond those agreements, interest in the territorial occupation diminished; furthermore the Mediterranean route to India was of doubtful value to Great Britain in face of recent events. And most important of all, the Arabs were not a people to be mandated and colonized, but considered themselves equal to any. El-'Iraq has obtained her independence gradually since 1927, while for Syria and the other Levantine states the transition from French mandate to independence is under way. Palestine and Transjordan are the

objects of recent discussions, tending similarly. Except for a very few restricted localities (Haifa e.g.) the western powers have today lost most of their former territorial interests in the Near and Middle East; at the same time those areas are all the more important for supply of oil to France and Great Britain.

POPULATION

A government census taken in 1932 gives the following figures for the different administrative divisions or *liwas:*

prevalent in all oriental countries; in the relatively cold winter, bad housing conditions often result in pneumonia. Reduced death-rates in general, as well as restriction of pests and epidemics through better water supply and hygienic control of the inland and the frontiers, together with steady economic improvement are likely to play a revolutionary rôle in increase of population of the Orient in the near future. The great possibilities are most clearly demonstrated, if today's population figures are compared with those of former days —at the time of the caliphate over 15

TABLE III

POPULATION DISTRIBUTION

I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*
a. Mosul	268,844	18,997	11	73,058	7,537	24,063	392,510
b. Arbil	99,670	220	....	3,795	3,090	.....	106,775
c. Kirkuk	122,610	11,204	....	1,308	2,633	134	137,889
d. Suleimani	101,282	.....	106	194	1,343	7	102,932
e. Baghdad	192,187	96,165	153	27,292	42,799	244	358,840
f. Diyala	43,086	39,321	1,483	488	2,252	227	86,857
g. Kut	2,569	117,344	5	72	346	51	120,387
h. Diwaniyah	3,388	337,083	....	27	531	39	341,068
i. Karbala	485	106,804	....	.....	.....	.....	107,289
k. Hilla	2,270	207,000	....	110	1,000	60	210,440
l. Dulaim	129,856	474	....	107	897	16	131,350
m. Basrah	53,752	182,381	....	4,150	7,260	378	248,281
n. Amara	4,497	255,995	....	229	2,540	1,972	265,233
o. Muntafiq	3,337	221,545	....	55	555	1,734	227,226
p. Southern desert	2,000	18,000	....	.....	.....	.....	20,000
Total	1,029,833	1,612,533	1,758	110,885	72,783	29,285	2,857,077

N.B. I.....administrative divisions (liwas) see Figure 12.
II.....Sunnis
III.....Shias
IV.....Unorthodox
V.....Christians
VI.....Jews
VII.....Others
VIII.....Total

Later estimates (Dec. 1936: 3,360,000) show definite increase of population, particularly if compared with the first census taken shortly after the war (1920: 2,849,282). The steady increase reflects improvement of economic and social conditions. Until recently hygiene and medical care were restricted to but a few rich folk. All kinds of skin diseases, trachoma (eye disease), typhus and typhoid fever, dysentery, and other serious illnesses are but a few of the unusually widespread group of diseases

million. Some authors believe that the country could support 100 million people.

Except for a few rich families, the living standards and also living costs (houses, food, etc.) are extremely low. With $25.00 monthly a well-to-do middle class native, e.g. a clerk or small business man, could pay his and his usually large family's expenses; the total expenses for the simple people are but a few dollars.

According to various estimates, density of population for the whole country

ranges between 1.0 and 1.2 per qkm. But average figures necessarily give a wrong picture of the situation and demand careful analysis of various areas and groups.

In the whole of the Orient three different classes of people are to be distinguished, which among themselves again show many minor differences; namely the nomads, the fellahin or farmers, and the city dwellers. The nomad tribes occupy all the territory which has no agricultural value, i.e. about two-thirds of the country's surface. They include the true Bedouins, the camel breeders of the Arabian desert; the Arabs, who in many instances (livestock e.g.) rely upon the rivers and live in their vicinity; and also many Kurdish nomad tribes of the southern steppe of the piedmont district. The farm population again shows great structural differences according to the two main farming areas, the southern area where irrigation is indispensable, and the northern area, includ-

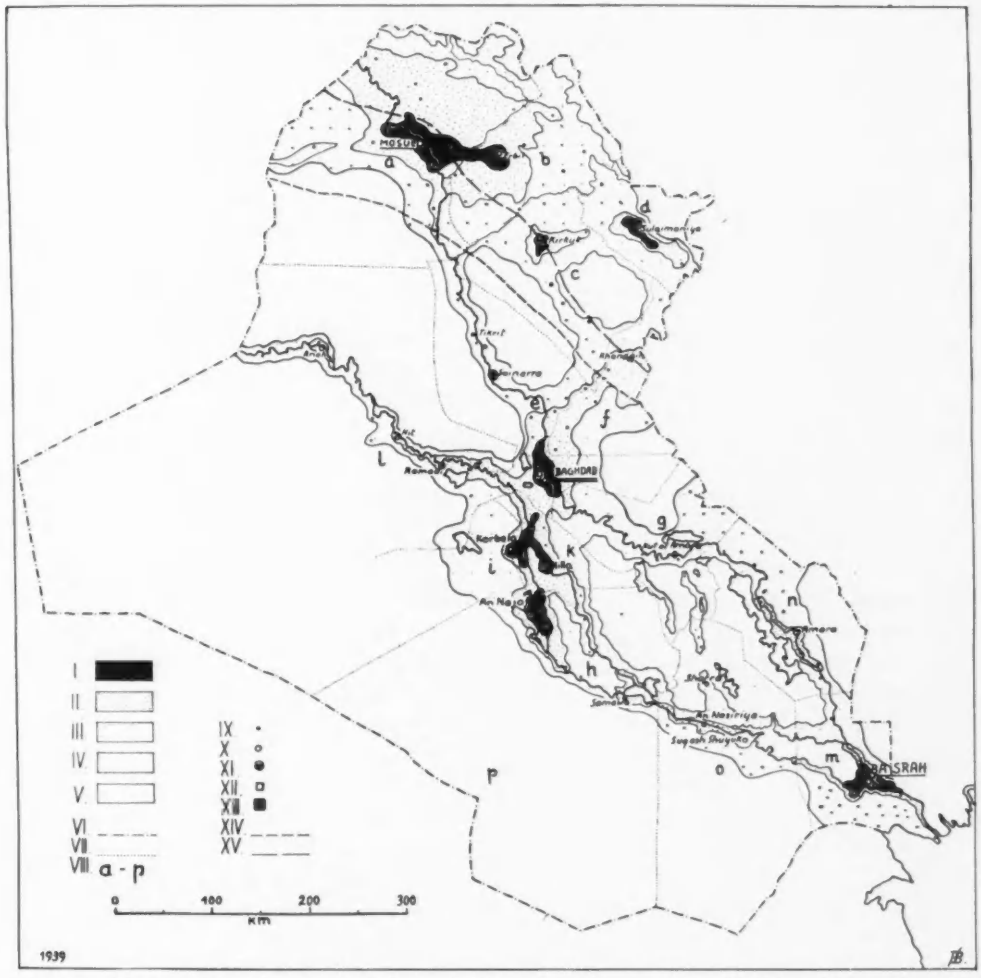

FIGURE 12.—Distribution of population. I. More than 25 per qkm. II. 10 to 25 per qkm. III. 1 to 10 per qkm. IV. Less than 1 per qkm. V. Lakes, ocean. VI. State boundary. VII. Liwa boundary. VIII. a-p refer to names of liwas mentioned in text. IX. Town with population of less than 5,000. X. Town with 5,000 to 25,000. XI. Town with 25,000 to 50,000. XII. Town with 50,000 to 100,000. XIII. Town with more than 100,000.

TABLE IV

DISTRIBUTION AND DENSITY OF POPULATION

1. *Total:*
   Area: 302,000 qkm — population: 3,600,000 — density: 1.2/qkm
2. *Tribal area:*
   Of the 3,600,000 inhabitants approximately 600,000 may be nomads.
   Area: 200,000 qkm — population: 600,000 — density: 0.3/qkm
3. *City population:*
   Approximately for the whole country: 800,000.

Principal cities:				
Baghdad	300,000	An Najaf	35,000
Mosul	80,000	Samarra	33,000
Karbala	65,000	Sulaimaniya	32,000
Basra	65,000	Kirkuk	30,000
Kadhimain	65,000		

4. *Rural population:*

Total farm area (including potential)	62,000 qkm
Total rural population	2,200,000
Density	35.5/qkm

	Southern Area	*Northern Area*
Population (without nomads)	2,250,000	750,000
Rural population	1,600,000	600,000
Farm land (qkm)	33,300	28,700
Density/qkm	48	21

ing the mountains, where wheat and barley are generally grown without irrigation. In North America and in Europe, cities of a non-industrial and non-commercial character are usually to be studied in relation to the farm land; this is however not true in the Orient. There are, to be sure, many small towns of a few thousand inhabitants, which serve as commercial and social centers for the farm population; there are also some towns which are wholly or partially marketing, shipping, or administrative centers. On the other hand, large towns, surrounded by their gardens, display a life of their own; many are religious places and places of pilgrimage, with temporarily large population; they have no direct functional connection with the surrounding country. Such strange oriental cities play important rôles between the Mediterranean and India. An analysis of the distribution of the population should therefore deduct the city dwellers and compare the three types separately (Table IV).

Table III on total population figures has already indicated the various religious divisions. In the West one rarely realizes the deep differences between Sunnis and Shias, two different sects of Mohammedans, who, if they should clash, could endanger the stability of the whole state. Two minorities stand out: The Christians and the Jews. The former are remnants of old Christian churches—missionary work having no influence at all—mainly in the north (Mosul area) and around Baghdad; they are split up in many different fractions of which, the best known are the Assyrians and the Chaldeans. The Jews are evenly distributed over the whole country, but live almost exclusively in towns and cities and range from poor shopkeepers to influential bankers and land owners; small in number they exert, nevertheless, a great influence. Naturally the Arab population dislikes them because of recent events in Palestine.

To such minorities belong remnants of the old Turkish administration, mainly concentrated along the piedmont towns Mosul-Erbil-Kirkuk and in Baghdad and Basra; the Persian element is represented at the entrance from Iran, in the Khanaqin area, as well as in the religious centers of Karbala and An

Najaf; and finally the Yezidis of the Jebel Sinjar and Mosul district, who again have their own customs and religion.

Generally these minorities differ—with the exception of the Jews—only in regard to religion, but not always necessarily racially, from the large Mohammedan majority. The latter again forms two groups; namely the Kurds, numbering about six or seven hundred thousand and occupying northern mountains and the piedmont, and the Arabic group. The Kurds differ from the Arabs racially, linguistically, and culturally. They are of Indogermanic origin. The Arabs can best be described as a group using one language and being in general of one racial origin; however through history large racially different groups have been amalgamated by the original Arabs and have today to be regarded as true Arabs. The slave trade has brought many different racial elements from the north (Caucasoid), and the south (Negroid) in the course of history to the Arabs.

Differences of race, language, and religion cross each other. In each cross it must be determined, which one has the greatest influence in the relationship between the different population group. El-'Iraq today is as united in religious matters as it is divided into different fractions with regard to race or language.

ECONOMIC SITUATION

Agriculturally the country has developed in close accordance with the natural divisions, while on the other hand industry has followed quite distinct directions. Finally routes of transportation and commerce result from the distribution of both; hence the following succession in the present discussion: (1) agriculture, (2) industry, and (3) communications—trade and commerce.

Agriculture

The southern area (a) includes all the territory, where precipitation is not sufficient for wheat and barley growing and any attempt at agriculture must rely at all times of the year upon irrigation. Only the actually or potentially irrigated area is included under this heading, while all the intermediate areas are treated separately and together with steppe and desert (c). Toward steppe and desert the boundary is necessarily sharp; sand dunes, rocky cliffs, or steppe follow with a sharp break beyond the irrigated fields and palm groves. But toward the north a zone follows with increasing rainfall, where in favored years wheat and barley may mature without irrigation on the fertile steppe soil, while they dry up in others; to grow wheat in the latter, means risking the entire crop. Here the farm land extends beyond the irrigated fields, but only with special methods and technics (dry farming) can the farmer expect a fair harvest. This marginal belt grades into the northern area (b), including the mountains, where wheat and barley are grown without irrigation with harvesting in spring; truck gardening and fruit growing, carried on all through the summer, must, however, have irrigation here as well as in the south.

Based upon its irrigation system Babylonia developed in ancient times the foundation of western science (calendar, mathematics, etc.), while Assyria in the northern area was able to develop her empire to a military power of far reaching influence upon the more evenly distributed cultivation and population.

The important dividing line between northern and southern areas is therefore mainly determined by the extension of wheat growing. In southern California wheat can be grown with an annual

precipitation as low as 261 mm (10.3 inches); in southern Russia 211 mm (8.3 inches) are sufficient, but give a poor yield. In the Mediterranean 254 mm (10 inches) are generally considered enough; but as little as 203 mm (8 inches) will do under specially favorable conditions. Apparently the amount of rainfall necessary for successful wheat growing depends first upon the species of wheat chosen. *Triticum durum*, or macaroni wheat, is the least exacting in its moisture demands; it is immune against rust and resistent to drought. nual distribution of precipitation is of great importance; in el-'Iraq rain falls exclusively within the growing and maturing season, when evaporation at the same time is unimportant, due to low winter temperatures. The Koeppen formula for determination of the limits of farming dependent upon rainfall, uses this connection between precipitation and temperature; if to the annual rainfall P $\frac{P}{3}$ is added (in countries of winter-rain; by summer-rain subtraction) we obtain the corrected rainfall figure P′.

FIGURE 13.—Euphrates valley between Al Quaim and An-Nahiye. Vegetation on salty-loamy soil at the edge of the arable land. The tall grass is called "es-Sell," the thorny shrub to the right "serr."

The Kurds of the Arbil plain grow two varieties of wheat, a hard one called Reshgul, or "black flour," used for wheat meal and burghul, and a somewhat softer one, Kandahari, used mainly for wheat bread; barley is of the black variety. Good results were obtained from Australian seed introduced earlier by the British authorities for it produced a much higher yield than native varieties. Foreign seed is however, too expensive to be generally used, while native seed is adversely affected by high admixture of weeds, due to careless planting and sorting. Second an-

The divisional quotient y is obtained as P′: T, P′ expressed in mm and T-mean annual temperature in C°. The subtractional quotient P′ − T = y′ results, if P′ is expressed in cm and T in C°. The limits of farming based upon rainfall are given for y = 15 and y′ = 12. Typical figures for el-'Iraq are:

	y	y′
Diyarbekir (T)	40.8	49.2
Mosul	27.3	34.7
Baghdad	10.8	1.8
Babylon	6.3	....
Basra	9.2	....

It should be noted, that Mosul lies very near the actual limit of the northern area, even if the two quotients y and y′ are still relatively high; they do however not consider, that the first rains in late autumn and winter fall on a country bare of any vegetation after the prolonged summer heat, and that consequently the ineffective run-off—connected with soil erosion—is considerable. Dry-farming methods, in some instances similar to the system developed in the western north American plains, play an important rôle in the southern marginal belt; in many places fallow land is covered with camel thorn, that draws up moisture, is humus-forming, and prevents soil erosion; it also serves as fuel and fodder. Except for pests, locusts, etc. the crop is mainly endangered by cold springs which retard maturity, and by failure of the late spring rains. But wheat is also grown by the nomad and semi-nomad Arabs of al Jazira and es-Shamiya in places, where rainfall is 4 inches (102 mm; Haditha) and less; there the occasional rainfall of a whole valley watershed is conducted to a few small plots where a low yield may be harvested in early summer. Here we find also the prototypes of our wheat (*Triticum dicoccoides*) and barley (*Hordeum spontaneum*) growing wild among the grasses of the steppe.

Further fluctuations of this important limit are caused by the great annual range of precipitation. At Hindiya observations of over 16 years give the following figures:

Max. annual precipitation.....	568 mm (22.31″)
Min. annual precipitation.....	37 mm (1.47″)
Mean annual precipitation.....	160 mm (6.30″)

FIGURE 14.—Al Ga'ara, a basin about 800 square miles large and surrounded by high cliffs, is one of the outstanding land marks between Rutba and the Euphrates. A number of watering places and the poor pasturage offered by the dense stand of camel thorn make it during summer a meeting point of Bedouins from several tribes, Dulaim, S'leb, but mainly Aneze. The old Kubaisa-Palmyra road, later followed by the track of the Eastern Transportation Co., crosses the Ga'ara; this track is hardly used today, the southern Rutba road being favored.

The variability for Babylonia as a whole is from 49 to 607 mm; the figures may be representative for the whole of el-'Iraq. In favorable years marginal areas give extremely good harvests, compared with best returns of the more central wheat areas, which may account for the farmers' persistence in taking the risk. In marginal areas returns for wheat can be 30 to 40 fold, compared with 8 to 15 in the central piedmont and 5 to 8 in the mountains (Erbil liwa).

Wheat and barley constitute the main grain crops. There is about twice as much wheat as barley grown in the north, while in the southern irrigated area the relation is just reversed.

Southern area—Even granted that there

FIGURE 15.—Al Quinaitra below Al Quaim in the Euphrates valley. Encampment of the Dulaim Arabs; unlike the true Bedouins, the Arabs live along the river and rely upon it as a source of water. Instead of camels they raise horses, donkeys, sheep, and goats, even cows; the tents are better constructed, as shown by the straw mats. With regard to tribal organization there is however no essential difference between the Arabs and the Bedouins.

is enough water available for irrigation, not all the land could be used for agriculture; only relatively small zones on either side of the main rivers are elevated enough to secure the necessary drainage, while most of the land between is marshy in spring and dusty-loamy salt desert in summer. Only the former may be considered potential farm land, upon which irrigation is the main problem, while for the rest, drainage would be equally important.

Since drainage areas of both the Euphrates and the Tigris lie within the regions of Etesian rains, the flood arrives in spring, primarily caused by the melting of the snow in the Kurdish and Armenian mountains. This is one of the main differences, when irrigation problems are compared for el-'Iraq and Egypt. During flood, another unfavorable factor is the great amount of silt carried, being about four times that of the Nile. Any large scale irrigation project needs large reservoirs at the head to serve in waterstorage, desilting, and discharge basins for the main flood. Without them any system of barrages and diversion canals is not fully effective. Until 1875 the navigable Shaklawiya canal, connecting the Euphrates with the Tigris below Baghdad served as a flood discharge canal; its closing by Midhat Pasha caused a silting up of the higher eastern Hilla-branch in the Euphrates below this, while the western lower Hindiya-branch was devastated and the water level generally lowered. Today Lake Habbaniya (146 qkm) serves as a discharge basin for flood water below Ramadi; at low water the water is fed back for irrigation purposes. An extension of that scheme is possible, if Lake Abu Dibis (potential area of basin 1200 qkm) be also included. Loss of water through evaporation in flat reservoirs and also in marshes and swamps is great; hardly one-fifth is available for irrigation purposes and navigation farther downstream. The Hindiya barrage at the head of the two main branches of the Euphrates, namely the Hilla and the Hindiya-branch, serves mainly for flood control and diversion of the water into the different branches and minor canals.

Possible extension of irrigation is therefore limited not only by land suitable for agriculture, but also by amount of water available for irrigation; reasonable estimates range from 15,000 to 35,000 qkm, but some authors have spoken of even 100,000 qkm. The higher figures are probably more nearly correct, if all potentialities are considered. Probably over 50,000 qkm are susceptible of irrigation, but the waters of the Euphrates, the Tigris and the Diyala combined are only sufficient for 30,000 qkm, considering the great loss through evaporation in reservoir lakes.

All through the southern area is found the typical three-floored oriental irrigation cultivation; dates as the main cash crop, fruit trees (citrus fruits, pome-

granates, etc.); barley (a second cash crop), wheat, corn, and rice; and all kinds of vegetables. Generally only small livestock is raised, while the meat supply comes mainly from the marginal steppe (sheep, goats) and marshes (buffaloes).

Date trees are grown commercially up to Ana on the Euphrates, beyond Samarra on the Tigris, and Khanaqin on the Diyala. The most important area of date production is however the Shatt-al-Arab, i.e. the combined Tigris and Euphrates below Gurma Ali. Dates are el-'Iraq's most important cash crop and major article of export. Except for barley other crops are mainly used within the country and consumed locally.

Cotton may develop into another cash crop, according to experiments carried out by the English. However cotton is grown but little today; as a source of raw material for local textile industry cotton may have a greater future, than as contributor to the world market.

Northern area—The northern area has already been described in its contrast to the southern portion; it is the area of winter-wheat without irrigation and summer-crops with irrigation.

Primarily wheat and secondarily barley are grown on the non-irrigated large fields that occupy the Mosul area, the Erbil plains, and partially the surroundings of Kirkuk; they constitute the granary of el-'Iraq and are important for both local and foreign marketing.

In addition irrigated gardens produce the greatest variety of vegetables (beans, onions, cucumbers, tomatoes, etc.), fruit trees (apples, pears, peaches, prunes, walnuts, figs, in the Mosul area also the typically Mediterranean olive tree), melons, and grapes in mixed culture. Rice, sesame, tobacco, corn, and cotton are grown commercially so far in relatively small quantities.

FIGURE 16.—Ana, five miles below Rawa, is a busy little town on the Ramadi-Deir es Zor road. The cañon of the Euphrates has deepened and leaves only small terraces and the islands for agricultural production. Adobe buildings.

In the southern marginal belt (Tigris below Sharqat and country south of Kirkuk [Tuz Khurmatli]), the importance of irrigation culture in comparison with non-irrigated farm land increases, and finally includes wheat and barley fields as well.

On the other side towards the mountains, and especially in their higher northeastern parts, irrigation plays a less important rôle. Improved farm land with substantially the same type of agriculture as in the piedmont area is restricted to the broad longitudinal valleys. While the Makhul-Hamrin range is without any trace of vegetation, Sinjar and Qara chauq show scrubby dwarf oaks. They constitute mainly the thin forests that dot the rocky slopes of the Kurdish mountains up to an altitude of 5,500 feet. Above them are meadows serving as summer pastures for Kurd flocks, and rocky peaks rising 9,000 to 10,000 feet. As result of increasing precipitation the inner ranges show much better forests, producing charcoal and gallnuts, the latter a valuable article of export because of their high content of tannic acid. In addition to these and the products of

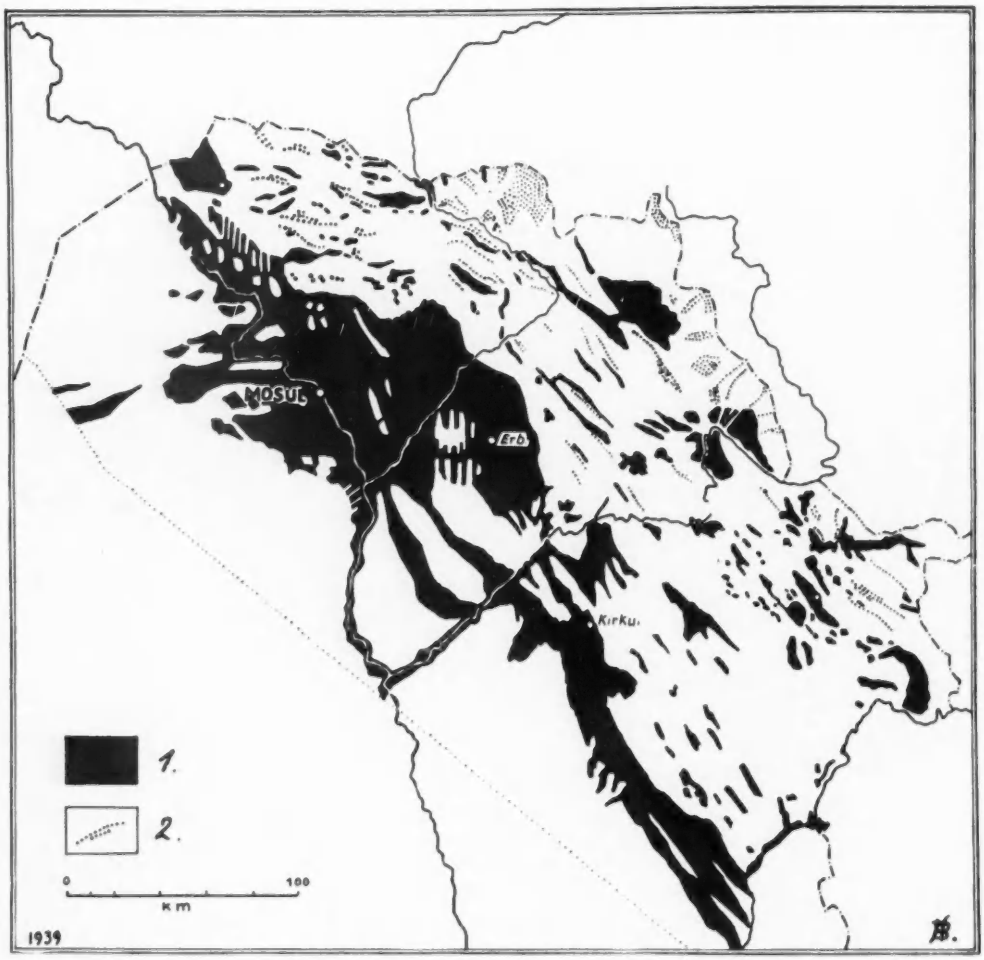

FIGURE 17.—Land utilization of the northern area. 1. Actually cultivated land. 2. Continuous forest area. (After "Question de la frontiere entre la Turquie et l'Irak." League of Nations report 1924.)

the farm land, the piedmont market places show a lively trade in honey, wax, resins, timber, dye-wood, hides, and live animals.

Most of the northern area is settled by Kurds, who have maintained their tribal organization despite the fact that they have settled in villages and towns. In the mountains, transhumance of at least part of the population, prevails, while in the southern marginal belt a great number of Kurdish tribes have adopted the Bedouin mode of living. There are striking contrasts between the generally very dirty villages of the lowland with their adobe buildings, and the clean kept villages in the mountains, with their trim fields and nicely cut hedges around their gardens. Sulaimaniya, Kirkuk, and Erbil are the three principal Kurdish settlements, while the appearance of Mosul, the big gate through which most of the northern trade flows, is more that of an Arab than of a Kurdish town.

Steppe and desert—The steppe areas, and even the deserts, generally considered and described as unproductive, covering about two-thirds of the country's surface, are nevertheless of great economic value, not only as open roads for the ever increasing traffic, which flows back and forth between east and west, but also as sources of certain commodities.

Contribution of the nomads to the economy of the country is considerable despite the scarce population; live animals, milk and butter (ghee), wool and camel's hair—the latter two, important goods of export—are traded for tea, sugar, textiles, and various utensils needed by the Bedouins in small towns bordering the desert area. The nomad must rely upon the settled area for his needs; but also the farmers, and more so the city dwellers, derive many goods from the nomads. The mutual relationship makes it therefore hard to understand that the nomad, according to prevalent opinion, should represent a particular stage of development of human social life.

FIGURE 18.—Water-wheels, or *nauras*, are usually 45 to 60 feet high and driven by the river. In small earthen pots the water is lifted into the irrigation canal. Of the four wheels one is generally under overhaul; thus one naura may lift water for fifty years and more continuously. The material for the nauras comes mainly from the date tree, which furnishes the timber as well as the ropes.

Compared with conditions twenty years ago, the economic situation of the tribes has grown worse through the complete disappearance of the camel caravan and the pacification of northwestern Arabia. This is all the more true as tradition and custom of the Bedouins are not in accordance with new political and economic ideas of the present ruling class. He has first to find his place in the new state. The bureau of tribal affairs plans to settle the shifting population around newly drilled water wells; thence extensive pasturing could be developed, perhaps with some subsistence gardening. At the same time, control over the tribes would be more effective, and education and hygiene could be extended to the black Bedouin tents.

New state boundaries have segmented the large life-areas of most tribes and special international agreements have had to be made to guarantee their vital interests. After long centuries of mastery of most of the country, the

FIGURE 19.—Where the difference of altitude between water level and fields is less, horse driven water-wheels with a continuous belt are often used. Euphrates between Al Quaim and An-Nahiye.

Bedouin sees again the organized state extending everywhere; a new period is coming, and it is to be hoped that for both sides, the tribes shall find their adequate social and economic position in the new world.

The relative importance of the various different parts of the country is best shown by studying the export of the four principal agricultural products:

PRINCIPAL AGRICULTURAL EXPORTS

(in Iraq Dinars [I.D.])*

	*1934–35***	*1935*	*1936*
Barley	693,685	261,829	781,683
Wheat	36,372	52,794	252,147
Wool	233,847	261,471	467,888
Dates	925,539	975,966	863,761
Hides and skins	.....	126,692	193,980

*The Iraq Dinar to 1000 fils is au pari with the Pound Sterling (1 I.D. = 1 £).

**Year ending March 31.

Here barley comes both from the northern and southern areas, but more from the latter, while wheat is mainly of northern origin. Wool is a product of the marginal steppe and desert, as are hides and skins, while dates are entirely produced in the south. Since agricultural exports are here "surplus-exports" (as compared with "forced-exports" in other countries) they are subject to reduced production as a result of droughts for example. In connection with study of population figures, they show the great possibilities of the country without a necessary industrial development.

If the yields of the main products in oriental countries are compared with one another in quintals per hectare, the significance of improving the methods of production is best demonstrated (Table V).

Except for sugar and tea el-'Iraq does not import agricultural products in large quantities. Of the two cane sugar from India might very likely be replaced wholly or in part by beet sugar grown in the country. Experimental work in the Erbil region by the British authorities have several years ago shown possibilities; but as in the case of cotton, not much development has followed the first experiments. Cotton and sugar beets remain therefore still two major fields of possible new development; they would both allow development of local industry, with local supply of raw materials and ready local market, and would at the same time reduce considerably two heavy import items.

To anyone who knows the Orient, it is not surprising that development along new lines does not proceed fast. Farmers and landowners are conservative, and only necessity, such as increasing population pressure, can call forth an extension of the farm land and increasing production. Coöperative thinking and action, as demanded by the introduction of new crops and methods, completion of marketing organizations, and any kind of large scale irrigation work, is lacking in the Orient; here it has been and still is, the duty of a wise government to assume respon-

TABLE V

YIELDS OF MAIN PRODUCTS IN ORIENTAL COUNTRIES

(in quintals per hectare)

	Wheat	*Barley*	*Rice*	*Tobacco*	*Cotton Gin*	*Cotton Seed*
Iraq	4.4	6.8	12.4	11.6	1.7	4.0
Iran	10.7	11.0	20.7	18.1	2.9	6.7
Palestine	4.6	2.6	....	4.6	....	....
Syria and Liban	8.2	10.4	35.5	4.6	1.7	3.6
Turkey	10.5	12.7	29.8	7.5	2.5	5.0
Asia (total)	8.1	11.2	16.1	11.2	1.5	3.5
U. S. A.	8.6	9.5	25.3	8.9	2.2	4.1
Egypt	21.0	20.6	35.0	....	5.9	11.9
Brazil	....	....	....	....	1.5	3.5
India	....	....	....	....	1.1	2.6

The figures are for 1936, or where not available they were in a few cases estimated on the basis of the 1935 and 1934 figures.

sibility for them. In 1936 an agricultural bank, financed by the Iraqi government, was founded to promote agricultural and industrial development through advances of funds and credits.

Besides this conservatism the system of land tenure constitutes a major difficulty. Land laws are ancient and inadequate; titles and cadastral plans, dating back to Turkish rule, are for the greater part lacking, and inaccurate when available. To lay the basis for future steady development, and also, with the purpose of increasing revenues, the government is now first clearing up such questions, before starting large projects of agricultural development, irrigation, etc.

An important rôle is assigned to agricultural experiment stations, which will have a double function: to study climatic and soil conditions all over the country together with scientific and practical tests of new crops and methods, and to serve as educational agencies for the farm population. The latter is extremely important, considering that crop rotation, manuring, etc., are mostly unknown. Even without large capital investments agricultural production could be greatly extended especially in the northern area. With transportation, marketing, and shipping conditions improved, el-'Iraq has a promising future as a producer of agricultural products; today it still is—regardless of the importance of the "foreign-born" oil industry—a non-industrialized, typically oriental country, composed in large part of poor, but hard working farmers, nomads, and city dwellers.

From different statistical and geographic sources Table VI on land utilization has been prepared; it takes all facts available into consideration, but can be regarded as only preliminary.

Industry

The oil industry—The keen interest, which foreign powers take in Near and Middle Eastern affairs centers mainly around the oil industry. Oil is exploited by foreign and not by national companies. It should however be borne in mind, that the home countries would hardly possess the capital and trained personnel necessary to start exploration, production, and refining; furthermore the country itself would not offer sufficiently large market for oil products. A national company in opposition to the big oil companies would fight a losing battle on the world market. It is therefore only natural that the oil fields of the Orient are exploited through foreign

TABLE VI
LAND UTILIZATION

	Qkm	%
A. Farm land (actual and potential)		
a. Under cultivation:		
Wheat	13,150	4.35
Barley	8,090	2.67
Rice	1,210	0.40
Cotton (ginned)	260	0.09
Cotton (seed)	260	0.09
Dates*	1,000	0.33
Subsistence (vegetables, corn, etc.)	5,000	1.65
	28,970	9.58
b. Potential farm land:		
Northern area (fallow + extension)**	19,030	6.31
Southern area (extension only)***	14,000	4.64
	62,000	20.53****
B. Agriculturally not used (unproductive)		
Mountainous countries	25,000	8.31
Inundated, marshes, lakes	15,000	5.00
Steppe and desert	200,000	66.16
Total	302,000	100.00

*Approximately 30 million date trees in el-'Iraq.
**In the northern area, particularly in the dry-farming divisions, fallow land plays naturally an important rôle; the possibility of extending the productive area is perhaps less than in the South.
***Extension of farm land depends almost entirely upon large scale costly irrigation projects.
****Of this about 11 per cent (33,200 qkm) are within the southern area and 9.5 per cent (28,700 qkm) within the northern area.

capital. Through royalties and other advantages, stipulated in the concession titles, the national government is nevertheless substantially aided in the general development of the country's welfare.

Undoubtedly Great Britain takes the greatest interest in oriental oil fields. Figures for 1936 show that her consumption, including bunkering in Indian ports, amounted to 77,000,000 bbls., one-tenth of which was taken over by the bunkering stations of the British fleet bases between Malta and Colombo alone. If the total Empire production of 33,647,000 bbls. is compared with the consumption, the importance of the Near and Middle East fields with potential production of 121,000,000 bbls. is conspicuous (actual production 1936: 91,330,500 bbls.).

At first it was through the Anglo-Iranian Oil Co.'s (A.I.O.C.), development of the south Iranian fields (Majid-i-Suleiman, Haft-Kel, etc.; 1936: 57,386,666 bbls.) with large refineries in Abadan, that the fleet bases around the Indian ocean were primarily served. It should be noted, that here producing and refining installations are both within Iran, which fact gives the Iranian government necessarily a firm position against any undue demands by the British oil company.

FIGURE 20.—Water-lift near the I.P.C. gardens at Al Quaim. These very simple but clever devices are seen everywhere in the country. In a leather vessel, made from a camel, the water is lifted about 40 feet, and then with the help of two different ropes automatically emptied into the canal. Oxen and horses are used to lift the vessels. A field irrigated by a double lift produces from three to four tons of wheat.

In el-'Iraq production started first through the Khanaqin Oil Co. (so called "transferred territories" with Naftkhaneh oil field; refineries in Khanaqin), mainly intended to supply the local demands through the Rafidain Oil Co. (distribution company). The Iraq Petroleum Co. (I.P.C.), the concession area of which includes all the territory north of 33° N. latitude and east of the Tigris with the famous Kirkuk fields (Baba Gurgur), was founded in 1925; it differs fundamentally from the AIOC, as here—as an outcome of the World War—the following powers were interested with 23.75 per cent each: AIOC, Royal-Dutch Shell, Standard group, and Cie. française de pétrole, 5 per cent being local capital. From the Kirkuk fields, the only ones so far used for production, the crude oil is transported through two pipe lines to Haifa (620 miles; 1,000 km) and Tripoli (530 miles; 850 km) on the Mediterranean; thence it is shipped

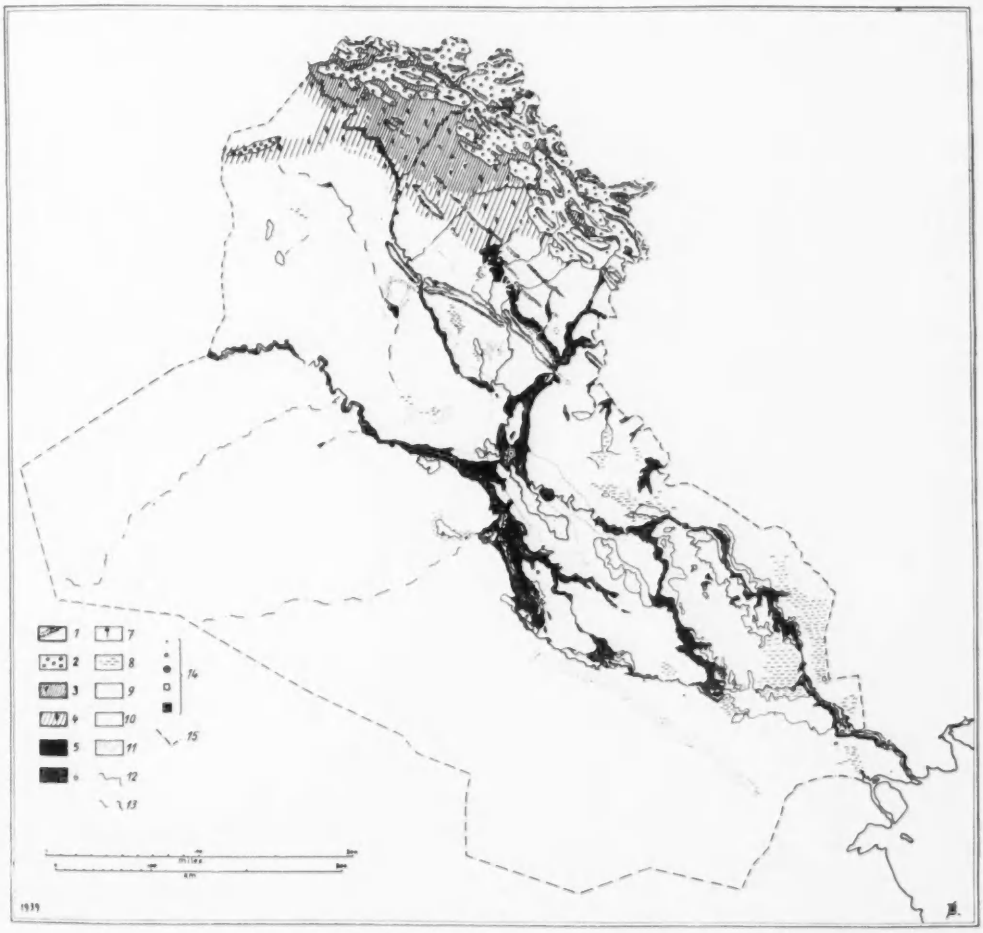

FIGURE 21.—Land utilization in el-'Iraq. 1. Mountains without forests, and area above tree limit. 2. Forests and areas of potential forest growth. 3. Farming dependent upon rainfall with additional irrigated summer crop. 4. Farming dependent upon rainfall with additional irrigated summer crop; marginal belt with dry-farming methods; frequent failures of crop because of droughts. 5. Irrigated land in general. 6. Irrigated land in general, main centers of rice cultivation. 7. Irrigated land in general, main centers of date production. 8. Swamps and marshy areas. 9. Regularly inundated areas with salty-loamy ground. 10. Desert and steppe, used as extensive pastures. 11. Sandy desert. 12. Rivers. 13. Wadis. 14. Towns as in Figure 12. 15. State boundary of el-'Iraq.

by tankers to French and British home refineries and to bunkering stations in the Mediterranean. Of the 1936 production of over 27 million bbls. about 20 million bbls. went to France by way of Tripoli, and the rest through Haifa mainly to fleet bases in Palestine, Cyprus, and Malta. This situation is, as compared with the AIOC, a distinct advantage of the IPC against any possible attempts to nationalize the oil industry.

Territory north of 33° N. latitude but west of the Tigris is the concession area of the British Oil Dev. Co. (B.O.D.), closely allied to the IPC; this company is not yet producing, but the near future will see the construction of a pipe line from the BOD Mosul-fields (Qaiyara) either along the IPC pipe line or directly through northern Syria to Alexandrette.

Other companies, all closely allied to the IPC-AIOC group and representing mainly British interests, have been founded in other states of the Near and Middle East; and through the Bahrein Oil Co. and the Am-Iranian Oil Co. the Standard group has also entered successfully and independently the oil fields of the Orient.

It will be noted, that el-'Iraq has still to offer the oil concessions south of 33° N. latitude, where according to recent newspaper information a concession has been granted to the Basrah Oil Co., a subsidiary of the IPC group. The Middle East oil fields lie principally in two belts north and south of the Mesopotamian trough, i.e. the Mosul-Kirkuk-South Iranian oil zone and the Bahrein-Kuweit zone, which possibly extends north to the ancient asphalt mines of Hit. The value of the concessions still unleased is therefore much greater today than so recently as only ten years ago and el-'Iraq possesses in them the possibility of securing necessary funds for developing her agriculture, industry, and national strength.

Middle East economic geography could today to a certain extent be described in terms of the oil industry. This is particularly true for the tribal areas of northwestern Arabia within the reach

FIGURE 22.—Kurdish village, perched on a small ridge surrounded by broad valleys. The flat-roofed houses can be seen in all parts; they are used as resting and sleeping quarters during the hot season, when life inside the houses is unbearable.

FIGURE 23.—Arab village between Mosul and Qaiyara. The good road was constructed by the Germans during the World War.

of the pipe lines. Not only has construction and operation of oil interests brought much ground and air traffic, and developed much used trans-desert routes; but after completion many local inhabitants have found work in the 12 IPC pumping stations—named K 1-3 on the Kirkuk-Haditha line, H 1-5 and T 1-4 from Haditha to the coast on the Haifa, resp. Tripoli branch—as employees in the engine rooms, maintenance, and for protection of the line and the stations; the Bedouins display high technical ability. This profound influence can hardly be overestimated, as it breaks with the traditional mode of living and ideas, handed down through centuries and tends to fix the shifting population around a few centers. The IPC has also drilled many water wells and operates an excellent medical service of its own.

The oil production in 1,000 metric tons in el-'Iraq was as follows; in 1934 the production of the IPC and the operation of the pipe line started.

1928	95	1933	115
1929	121	1934	1,031
1930	121	1935	3,682
1931	120	1936	4,011
1932	115	1937	4,258

Other industries—El-'Iraq has not developed other mineral resources to any extent. Several brown-coal deposits and various ores have been reported from the Kurdish mountains, but are only worked slightly. Sulphur and salt could be mined in large quantities; geological conditions indicate possibility of phosphate deposits, from the discovery of which great importance would accrue to the agricultural development (fertilizer). As a whole, it can be said that due to the predominant importance of the oil industry the study of other mineral resources has been neglected. Building and road material will be required in large quantities in the near future in the whole country, but so far, production of stone, concrete, etc. is slow and should be speeded up.

Around Baghdad and Mosul centers small industrial development, mainly of textiles and tobacco manufactures, both for the home market. It has been shown that a much larger textile industry (cotton and wool) based upon further agricultural development could be developed for the inland market. The problem presents itself here from another angle. The low population figures and consequent shortage of labor are a great handicap especially for cotton growing; on the other hand there has resulted an almost complete absence of trained labor as well as enterprising employers due to the almost complete lack of industrial development. Progressive labor laws have been passed by the Iraqi government for the protection of the employees.

Communications: Trade and Commerce

Communications—The natural routes for transportation, the rivers and canals, were of great importance in the past. Today only small native crafts, *keleks* and *gouffas*, float down the Euphrates and Tigris. On the latter the "Tigris & Euphrates S.S. Co." operates a regular passenger and freight service between Baghdad and Basra. From Maqil, Basra's harbor, the Shatt-al-Arab has been developed downstream as a waterway for seagoing vessels by dredging the dangerous bar; British, Japanese, German, and other ships call here and handle the greater part of el-'Iraq's imports and exports. The Shatt-al-Arab ports (Maqil, Abadan, and Khorramshahr) totaled in 1935–36, 929 steamers and a gross tonnage of 5,342,809 R.T. Since then Maqil has been further developed into an important and modern harbor.

The old trunk railroad line, the famous "Baghdad-Bahn," was never completed, and partly dismantled after the war. The missing link between the railhead at Tell Kotchek where the Baghdad R.R. enters Iraqi territory and Baiji is now under construction; with its completion el-'Iraq is linked up with the European railroad system. During and after the war a narrow gauge system between Baghdad and Basra-Maqil as well as Kirkuk and Khanaqin was constructed, to connect the capital with the country's seaport, the northern granary, and the gate to Iran. While the Baghdad R.R. runs through sparsely settled land, mainly assuring the connection between Baghdad and Mosul and the transit traffic, the narrow gauge railroad system is of a functional importance to the country's welfare. The railroads (1937: 752 miles and 176 miles of sidings, total 928 miles) are operated by the Iraqi State R.R., earnings amounting to (1936–37) 615,233 I.D. and expenditures to 538,289 I.D.

Transportation of freight and passengers by car is of increasing importance; road construction is therefore of primary necessity. The main dirt and gravel roads are being gradually replaced by well paved macadam roads, because only the latter can guarantee an uninterrupted safe connection all through the year. As a result of soil erosion and heavy traffic the former develop during the first rainy season into deep sloughs, that completely block traffic for days; and the next summer, instead of the road of a year ago, a line of hard sun-baked bumps and hollows forces the driver to find better going through near-by fields or simply across steppe and desert. In this way a track develops often a mile and more wide. Much of the traffic in el-'Iraq still flows along such arteries exclusively so in the case of the trans-desert routes between Damascus and Ramadi, with great inconvenience to transportation agencies.

FIGURE 24.—I.P.C. Pumping Station H-1. Each one of the pumping stations is a large establishment, surrounded by a high fence and guarded by special police. This picture shows only a small section, in the foreground the European living quarters with small gardens and a line of trees, in the background the engine rooms and the stores. The stations are usually 100 to 150 km. distant from each other, separated by desert or steppe. The company provides each station with every possible comfort to relieve the lonely life of the employees.

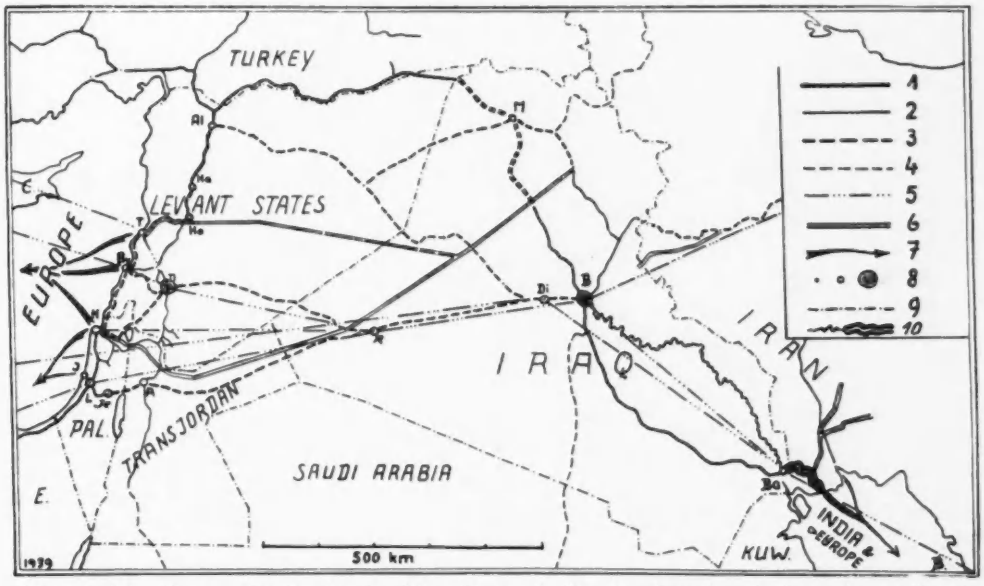

FIGURE 25.—Communication in the Near East. 1. Trunk railroads. 2. Secondary railroads. 3. Main automobile routes. 4. Secondary automobile routes. 5. Regular air lines. 6. Oil pipes. 7. Direction of shipping. 8. Centers of communication (T—Tripoli, By—Beyrouth, H—Haifa, J—Jaffa, L—Lydda, Je—Jerusalem, A—Amman, D—Damascus, Ho—Homs, Ha—Hama, Al—Aleppo, R—Rutba, Di—Dhibban, B—Baghdad, M—Mosul, Ba—Basra). 9. State boundaries. 10. a. Navigable for river boats; b. navigable for sea-going vessels.

The trans-desert traffic by car is a relatively recent development; two Australian brothers Nairn started the first reconnaissance trips in 1923; today transport by car has almost completely superseded the old camel caravan. Several routes have been tried by various companies; but now the direct Damascus-Jebel Tenf-Rutbah-Ramadi-Baghdad route is generally used. Except for the crossing of Wadi Hauran, where a bridge is sorely needed in winter, and several stretches of muddy ground in the rainy season, the track offers no obstacles and makes it possible to reach Baghdad from Damascus in 24 hours. The Nairn Co. now operates an express de luxe service twice a week between the two cities with extension to Beyrouth and Haifa. Other companies (Transports Transdésertiques Réunis) and private trucks and taxis handle the remainder of the considerable traffic. Another route reaches Amman and Jerusalem from Rutbah; the northern and southern branches of the pipe line are followed by much used roads. Important also is the connection along the Euphrates from Ramadi-Ana-Abou Kemal-Deir es Zor to Alep. Security from the nomad tribes is the first necessity; it has been shown earlier in this article, that their pacification has already gone far in the Iraqi and Syrian territory. But also over the tribes living in the northern parts of Saudi Arabia the police have a measure of control, for they must come every summer to the northern watering places.

Towards Iran the most important route is the one from Khanaqin to Kermanshah and Teheran, used by the convoy in connection with the Simplon-Orient and Taurus Express train as well as by the heavy local freight and passenger traffic. Another less used excellent road crosses the Kurdish moun-

FIGURE 26.—This truck had just left Rutba police station on its way to Damascus, when the car got stuck while crossing Wadi Hauran, blocking the traffic in each direction for a considerable time. Transportation problems during the rainy season are nerve-racking in this country, where in big flats the water is soaked by the ground and results in a deep mud.

tains from Erbil to the Iranian frontier towards Lake Urmia and Tabriz.

The most recent development is the rapidly increasing transport by air. All the lines from Europe to the East pass through el-'Iraq: The Imperial Airways to India and Australia, the K.L.M. (Dutch) to the Dutch East Indies, the Air France to Indo-China, and the Deutsche Lufthansa to Iran and Afghanistan. The latter company, operating the fastest service, connects Baghdad and Berlin regularly in 18–20 hours. In addition the Misr Air Lines (Egyptian) assure local service. Baghdad's airport is fast becoming a center between East and West; close by is Dhibban, where large establishments of the Royal Air Force watch over the British interests. Basra's new airport is one of the most modern in the Orient. In addition the planes of the IPC fly daily between Haifa and Tripoli to Kirkuk, with extension to Mosul and the Gulf areas.

The increasing importance these countries, and particularly el-'Iraq, display with regard to all kinds of traffic between East and West, can be both an advantage or a grave danger. Naturally it is the British Empire whose vital interests are primarily connected with this artery; but Germany is again extending her economic activities extensively through Turkey and Iran along the "mountain-axis" already as far as Afghanistan; and southward runs the line uniting the different parts of the Italian empire. Unstable and weak national governments could easily result in territorial occupation by one of these powers, but if they diplomatically guard the vital interests of the western powers, they will easily be able to make use of other advantages.

Trade and commerce—The inland trade is difficult to present, since statistics are not available; its character (barter trade, small scale marketing, bazaars, etc.) has already been described. The figures for the foreign commerce, as arranged in Table VII, give however a fairly accurate picture of the economic situation.

The table serves to illustrate the effect of the economic conditions described earlier in this article and requires little explanation. Interpretation of the rapidly increasing value of oil and oil products must not neglect the fact that they are not directly for the benefit of el-'Iraq, and only through increasing revenues and the royalties, as well as the value of the remaining concessions, does the oil industry affect the state.

Besides oil and oil products only agricultural products mentioned earlier in this article (page 352) figure among the goods exported from el-'Iraq in large quantities.

Significant is the position that Japan has gained in el-'Iraq's foreign commerce; while buying nothing from el-'Iraq, she is a close second to Great Britain in supplying the country with goods, mainly cheap textiles:

IMPORTS FROM JAPAN AND UNITED KINGDOM
(in 1,000 I.D.)

	1933–34	*1934–35*	*1935–36*	*1936*
Japan....	706	1,224	1,432	1,346
U. K.....	2,000	1,542	2,059	2,272

TABLE VII

FOREIGN COMMERCE

(all figures in 'Iraq Dinars)

	1934–35*	1935	1936
State finances			
Revenues	4,020,296	4,730,764	5,384,528
Expenditures	3,735,374	4,254,901	4,611,027
Excl. oil royalties amounting to	989,072	598,202	599,968
Excl. capital works expenditure	429,051	1,151,208	1,528,265
Commerce			
Imports	6,104,844	6,974,411	7,177,110
Cotton piece goods	911,000	950,000	805,000
Silk & rayon goods	351,000	369,000	383,000
Woollen piece goods	191,000	198,000	210,000
Sugar	381,000	368,000	374,000
Tea	243,000	237,000	295,000
Machinery, tools	332,000	408,000	490,000
Vehicles	215,000	291,000	271,000
Iron and steel	.....	516,000	827,000
Exports, excluding the IPC oil	.....	2,843,742	3,483,649
including the IPC oil	4,785,338	5,248,522	(for 1935–36*)
Customs gross revenue	1,867,051	2,077,188*	2,298,390
Transit	2,930,717	2,270,824	1,641,274
Distribution of trade			
Imports: United Kingdom		2,059,000	2,272,000
Japan		1,432,000	1,346,000
Iran		659,000	408,000
India		491,000	487,000
United States of America		432,000	459,000
Germany		390,000	464,000
Exports: Palestine and Transjordan		1,237,000	226,000
United Kingdom		1,120,000	1,040,000
Syria		1,059,000	.....
United States of America		536,000	692,000
India		391,000	313,000
Iran		233,000	157,000
Arabia		.....	157,000

*For the year ending March 31.
After Statesman's Yearbook 1937 and 1938.

In the future a great reduction of the transit traffic to Iran can be expected as a result of the completion of the Trans-Iranian railroad, connecting Teheran with Bandar Shahpur on the Persian Gulf.

Compared with other countries in the Near and Middle East, which exhibit a forced growth resulting from strong centralized governments, el-'Iraq has shown more natural development towards modern relationship between resources and peoples, typical for an oriental country.

EVOLUTION OF SHIPBUILDING IN SOUTHEASTERN MASSACHUSETTS

Paul Huffington and J. Nelson Clifford

THE present availability of hitherto inaccessible and unexplored sources of information has impelled the authors to begin a detailed geographic survey of the evolution of shipbuilding in New England. The results of the survey will appear in forthcoming issues of ECONOMIC GEOGRAPHY.

The authors plan a series of regional and type studies as the best method of presenting, in the light of regional and local environmental factors, the great amount of statistical and descriptive material which they have collected and interpreted. The location of the authors in the heart of the early shipbuilding center of the continent has enabled them to make personal intensive field studies on the sites of the old shipyards.

Hitherto studies have been made from historical, navigational, or descriptive points of view. The authors now present a geographical analysis of the industry.

The casual visitor to the shores of southeastern Massachusetts, viewing the great prosperity of this summer playground, little realizes the development of great industries which formerly flourished in this region. The early settlers here, faced with a rigorous, exacting environment were forced to utilize every available opportunity to supplement the meager living obtained by farming.

One of the chief industrial responses resulted from the favorable marine environment, and the inhospitable aspects of the forested slopes and rocky, sterile soil. The resultant of the two forces, combined with the necessity of keeping in contact with the mother country and the other colonies, in part stimulated the development of an early shipbuilding industry of notable magnitude.

An occasional historic marker, a decaying pier or launching way, or at most a small boat storage and repair yard, today mark the sites of once flourishing shipyards (Figure 1).

The early need for shipbuilding was based upon the necessity for the colonists to supplement the limited food supply and cash income obtainable from the land. Fishing vessels were required for bay and bank fisheries. In an unsuccessful attempt to start an English fishing colony, the thirty ton "Virginia," was constructed in 1607 at Stage Island in the mouth of the Kennebunk River, Maine. Vessels were also re-

FIGURE 1.—A tablet which marks the site where the "Fox Hill Shipyard" was located in the town of Scituate, Massachusetts, along North River; now a monument to a decadent industry.

quired for the West India and coasting trades. In 1631 the "Blessing of the Bay," the third vessel built in America (Figure 2) was launched on the Mystic River for trade along the New England coast and with the Dutch at New Amsterdam. Constructed for Governor Winthrop, it introduced New England to the West Indian products by way of Holland. Later, it and other vessels made direct voyages to the West Indies. In 1640 the 120 ton "Desire" of Salem brought home cotton, tobacco, negroes from the Bahamas, and salt from Tortugas in exchange for articles mentioned by Governor Winthrop when he said, ". . . dry fish and strong liquors are the only commodities for those parts." These articles constituted staples of the trade for the next two centuries, a trade which laid the basis of most shipbuilding as a separate industry following 1640.

1630
1930
BLESSING OF THE BAY
HERE GOVERNOR JOHN WINTHROP BUILT A BARK OF THIRTY-SIX TONS, NAMED THE "BLESSING OF THE BAY," WHICH WAS LAUNCHED JULY 4, 1631. THIS WAS PROBABLY THE FIRST VESSEL BUILT IN MASSACHUSETTS.

FIGURE 2.—Historic marker on the banks of Mystic River, Medford, Massachusetts, commemorating the third vessel to be built in America. The exact spot where its construction took place is not known.

There were many environmental conditions conducive to the development of shipbuilding of which the colonists early took advantage in order to supply the necessary vessels.

Of the physical factors involved in the establishment of the industry, perhaps the most important single factor was the post-Pleistocene subsidence of the land, which produced a number of physical conditions directly or indirectly significant in the growth of the business. It resulted in the drowning of the mouths of streams entering the sea, forming protected estuaries where ships could be built and launched without fear of wreck. It also formed protected harbors to act as bases for shipping activities of all kinds—fishing, trade, and military. It produced the highly indented coastline which encouraged personal and economic contact with the sea, and provided many harbor islands to serve their age-long function of encouraging navigation. It was a major factor in the formation of the fishing banks from Cape Cod to New Foundland, strong incentives to navigable enterprise because of the importance of their "harvest of the sea" to a land characterized by its poverty of soil.

Other factors were of equal importance. Neighboring large areas of mixed forests afforded abundant supplies of timber excellently suited to shipbuilding, and provided the naval stores needed for maintenance and repair of the fleets. Numerous deposits of bog ore in glacial lakes, and nearby potential power sites formed by disarranged drainage allowed iron-making for ship fittings. The tides coming considerable distances up rivers permitted location of shipbuilding sites well up the rivers near the timber supply.

Thus the happy combination of a shipbuilding unit within a river valley, bog ore and sources of streams in the lakes, power sites for forges along the upper courses, and building sites along the lower courses and estuaries. Adjacent glacial slopes provided forest containing abundance of oak and pine for hulls and masts.

Soon after establishment as a separate

industry along the Atlantic coast, shipbuilding underwent a process of segregation which led to concentration of the industry into the most favored areas. One such center was southeastern Massachusetts. Shipbuilding in this area was mainly confined to centers at Scituate Harbor, North River, Blue Fish River–Duxbury Bay area, Jones River, and Plymouth Bay. (See Figure 3.) Plymouth was the first of these places to begin building. In 1624 the Pilgrims brought over a ship carpenter who built two shallops and a lighter, and had timber for two ketches when he died of fever. They early recognized the importance of a strong shipbuilding industry by passing a law which required

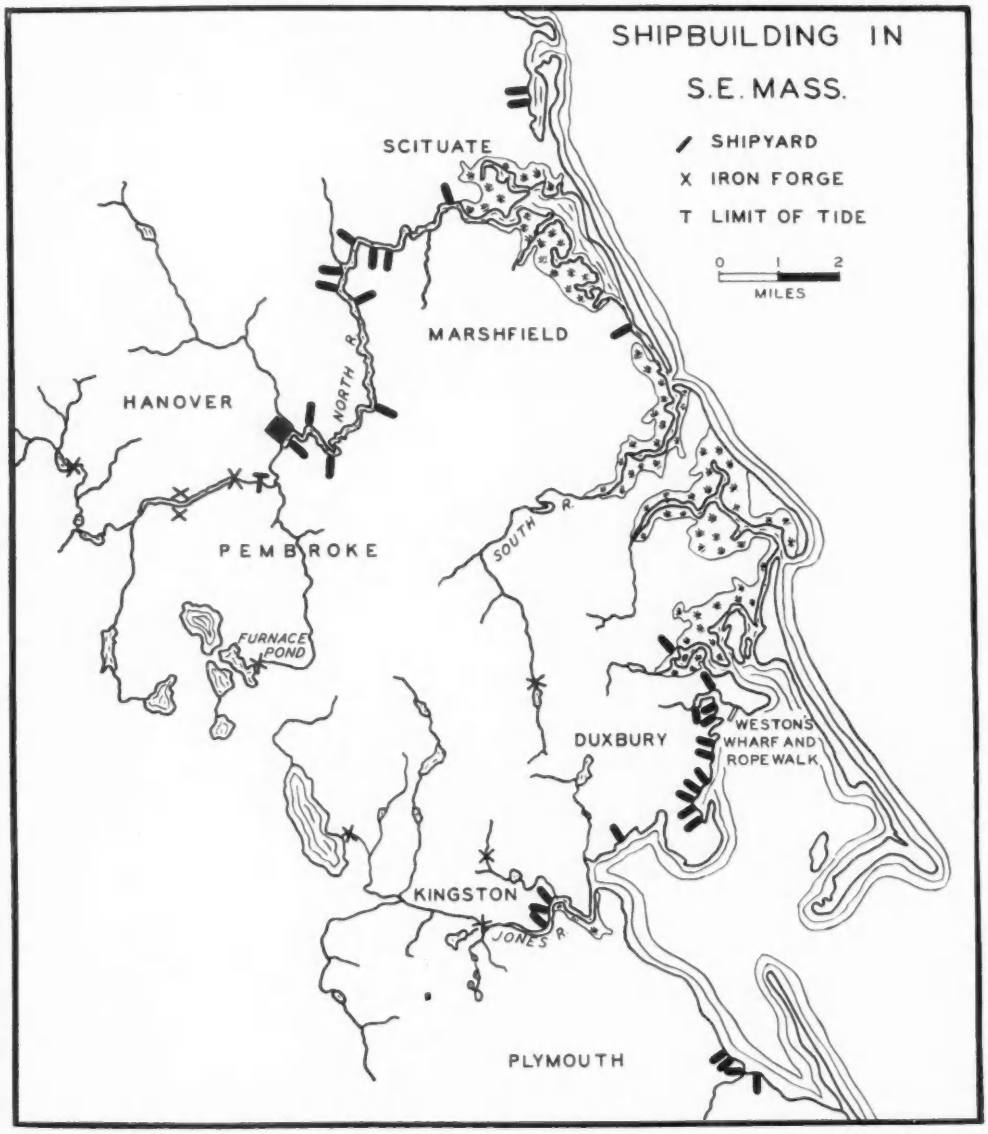

FIGURE 3.—Shipyards in southeastern Massachusetts were grouped about the most favored building sites; meanders of tidal streams such as at Jones and North rivers, and on protected bays, as Scituate, Duxbury, and Plymouth. The up-river ponds furnished bog ore, and downstream from the ponds, forges were located at convenient power sites.

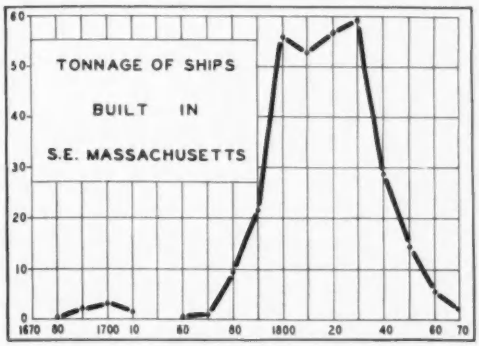

FIGURE 4.—Tonnage of vessels constructed in southeastern Massachusetts in thousands of tons, by decades. During the period from 1790 to 1840, the "heyday" of the American Merchant Marine, approximately 250,000 tons were built.

of builders that "nothing should be amiss in materials or workmanship." By 1633 settlement was made at Scituate, based upon an important fisheries there. Without doubt, shipbuilding was started shortly after, but the first recorded vessel appears in the Massachusetts State Archives as being built in 1678. By 1678 the industry had also spread to North River, where at the Briggs yard a brigantine of thirty tons was constructed. Although local Duxbury records reveal shipbuilding as beginning about 1719, the State Archives records show that a vessel of 35 tons was built there as early as 1703. Previous to 1714 a shipyard was located at Kingston, but no records of ships built there are found prior to 1727, when a 41-ton sloop was made there.

Utilizing the physical advantages before mentioned, the industry expanded in the area until it reached a peak of development, building approximately 224,456 tons of vessels during the forty years between 1800 and 1840. Early records up to 1714 show that the industry was rapidly increasing; following that year few records are available until 1789 when the United States Customs Houses kept records. (From "Narrative History of the Town of Cohasset, Mass." written in 1898 by E. V. Bigelow, we learn that, "All the records previous to the year 1776 were confiscated and taken to Halifax, Nova Scotia, when the British evacuated Boston, and were thrown into a damp cellar. Nearly seventy-five years later, when some accommodating Halifax officials searched them out . . . they were so rotten and rat eaten as to be utterly useless." Because of the paucity of accurate records for the period 1714 to 1789, any analysis of the trends during that time must be based upon the estimates made by early colonial officials.) However the business in Massachusetts apparently increased for a time, reaching a peak around 1769, then declining just before and during the Revolutionary War. So many shipwrights were attracted from England by special inducements that the builders of London complained to the Lords of Trade in 1724 and 1725 that ". . . the New England trade has drawn over so many working shipwrights that there are not enough left here in London to carry on the work."

The Journal of the House of Commons for 1769 shows that 389 vessels were built in the Colonies that year.

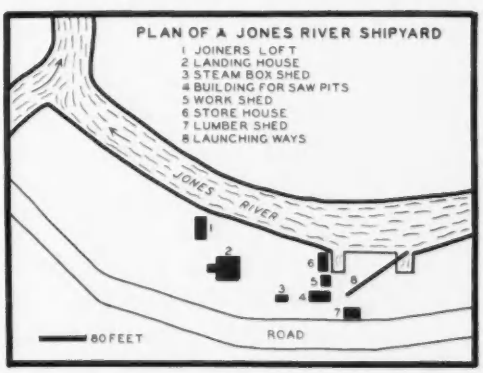

FIGURE 5.—Plan of a Holmes shipyard, one of the leading yards at the "Landing" on Jones River, Kingston. Note position of the launching ways to permit launching of vessels upstream when they were no longer than the width of the stream.

The same year Lord Sheffield estimated that Massachusetts Bay built 137 vessels totaling 8,013 tons, about 60 per cent of the tonnage launched on the entire Atlantic coast that year.

Foreign orders for vessels filled at Boston alone averaged about 40 per year from 1735 to 1738. For the next few years the orders were distributed as follows:

1738.....41	1746.....20
1743.....30	1749.....15

The decline is partly due to the gradual enforcement of the navigation laws.

Before the Revolution, 125 vessels were built in the colonies each year. Just after the war, shipbuilding virtually came to a standstill. From 1784 to 1785, 45 vessels were built; between 1785 to 1787, about 15 to 20 per year.

Following the period of privation and sacrifice necessitated by the war, efforts were directed toward the reestablishment of disrupted American trade. The vessels required by the renewed commerce accounts for the rapid rise in construction between 1789 and 1840 (Figure 4). By 1826, 92.5 per cent of American commerce (imports and exports) was carried in American owned vessels. During the period between 1800 and 1840 over two-thirds of all the vessels ever built in the area were constructed. The temporary decline during the decade from 1810 to 1819 was occasioned by the War of 1812 which so paralyzed shipping in all New England that in 1814 only 54.5 per cent of American commerce was carried in American vessels. After 1814 shipbuilding rapidly recovered, reaching its greatest development during the decade 1830 to 1839 when nearly 60,000 tons of ships were constructed.

FACTORS CONTROLLING EVOLUTION OF THE INDUSTRY

The first factor controlling the shipbuilding industry was location. Locations of shipbuilding sites may be grouped into three types:

1. Location on banks of the lower

FIGURE 6.—Building sites at the "Landing" on Jones River, today occupied by boat building and storage firms. The broad flats provide an excellent site for the buildings and launching ways. The remains of a channel lead to the river at the right of the first building. Such ditches were dug from deep water to the building stocks.

FIGURE 7.—Ruins of a shipyard at the break in the farther bank of North River. This is an excellent illustration of location on an area of flat, marsh-free land.

courses of rivers within reach of tide. This was the preferred and most common location, including a total of 18 sites in which there were 30 yards located on North river and Jones river. This type is further illustrated by the building sites on Jones river, which were located about one mile from the mouth of the river, where the tide rises from 8 to 12 feet, providing water enough to launch a ship of 400 tons (Figures 5 and 6). In the early period while ships were small this location was advantageous. It became also an important factor in the decline of river sites as the demand for ships exceeding 400 tons became common. Another factor affecting choice of sites was flat areas free from marsh, and large enough for the construction of ships (Figures 3 and 7).

2. Location on protected bays and coves formed by river estuaries. This type, of which 19 have been located, offered opportunity for locating larger yards where bigger and greater numbers of vessels could be constructed at one time, thus making for a larger tonnage per yard. The largest vessel built at Duxbury Bay was a bark, the "Thomas Goddard," of 715 tons, 154 feet long and approximately 35 feet broad and 13 feet deep. Here direct contact with the sea allowed both coastwise and foreign shipping to supplement the vanishing local materials (Figure 8).

3. Inland location. One yard at Duxbury was separated from the bay by the main highway, across which it was necessary to build ways, thus blocking all traffic at times of launchings. At peaks of demand for building sites at Duxbury, one yard was actually located a mile inland, from which it was necessary to use 100 yoke of oxen to haul vessels to the bay for launching!

The second controlling factor was the changing sources of materials. The mixed forest within the area at first provided a variety of woods for use in shipbuilding. Oak for planking and pine and hemlock for masts and spars proved superior to all other woods, so

these were soon used almost exclusively by ship carpenters. A great abundance of such timber was readily available in early times, but as the stock became depleted it was necessary to draw upon more distant sources. About 1815 supplies of timber adjacent to the yards were near exhaustion, especially trees of proper shape for the making of ships' "knees." It was necessary for a certain builder to purchase an entire woodlot, located some twenty miles inland, in order to get a single tree suitable for the forming of "knees." With the virtual exhaustion of local timber it became imperative to import it from forests of the southern states and Maine and southern New Hampshire. East Boston made and finished masts and spars for the builders of this area, and masts were freighted by coastwise schooners to wharves along the coast where they were "stepped" into ships. Mounting cost of ship timber coincident with increasing remoteness of supply became a contributing, but never a decisive, factor in the decline of the industry here.

Due to the difficulty and expense of obtaining iron, builders substituted wood for fastenings wherever possible. Planks were fastened by white oak pins called tree nails or "Trunnels." Such iron bolts and fittings as were needed were made from bog ore obtained locally. Forges were located in favorable spots for obtaining ore and water power (Figure 3). With the increasing number

FIGURE 8.—Location of Sampson's shipyard, later Keene's yard at Duxbury on the Blue Fish River estuary. This type of location allowed the building of larger ships than was possible in the up-river yards.

of ships built and failure of the local ore, it became necessary to turn to foreign sources for iron. The foreign iron was obtained as part of the return cargo for vessels leaving Spain, England, Russia, and Sweden. Swedish iron largely replaced local bog ore in Plymouth County, being a staple article of import until 1860.

For the entire life of the industry, builders relied upon foreign sources of hemp, duck, and canvas used in rigging the vessels. Hemp was largely imported from two sources, Russia for the poorer grades, Manila for the best. Russian hemp rope was used in places where a steady strain required strength but little elasticity, while Manila was utilized where elasticity was at a premium. Canvas and duck for sails were imported from St. Petersburg, Russia, and a little from other Baltic ports.

The local forests furnished sufficient naval stores to meet the demands of the early industry; however it soon proved imperative to look to the southern pine forests for these materials.

RISE OF THE INDUSTRY

The prosperity of the shipyards and the consequent rise of the industry was largely determined by two sources of demand for ships. The most important was sale or lease of ships to merchants outside the producing area; but of nearly equal importance was the employment of ships by the builders in fishing and trade. Ezra Weston of Duxbury, one of the leading merchants of his time, and said to be the largest ship owner in America in 1840, built and owned all the vessels employed in his trading ventures (Figure 9). Joseph Holmes, the most important builder of Kingston, referring to vessels built by him, said in 1859, "All but two I have fitted for sea and sent to sea on my own account and risk." Although the map (Figure 10) shows a world wide distribution of ports of call for the Holmes vessels, the heaviest concentrations are in the Mediterranean, Caribbean, Atlantic and Gulf ports, and the northwestern European ports.

FIGURE 9.—Site of the wharf and ropewalk of Ezra Weston, Duxbury's leading merchant and ship owner. Mr. Weston's ships were outfitted here and sailed to all parts of the globe.

Demand for ships presented by these two outlets was controlled by conditions prevalent in travel and trade. Lack of a good highway system forced all intercolonial traffic to be sea-borne. Trade with the West Indies, the Mediterranean, and Northwest Europe and Southeastern Asia, as well as the coasting trade, was expanding rapidly, creating tremendous demand for vessels of all rigs and sizes. Practically all ships built in the area entered one or more of these trades.

The principal commodities carried in vessels sailing to the Mediterranean were: dry salted codfish, sugar, and barrel staves. The staves were left at the principal wine ports. On the return trip the ships called at various ports making up their general cargoes of Mediterranean products, consisting of dried fruits, citrus fruits, wine, salt, sulphur, marble, and other specialized products of the region. The Boston market placed a premium upon the first ship to arrive with each new crop of

citrus fruits, which sometimes amounted to a differential as high as $10,000. This great demand for speed in the Atlantic crossing lead to yearly races between the ships engaged in the Mediterranean fruit trade. These efforts to be first to deliver cargo in Boston caused the captains to crowd on so much sail that sudden storms often resulted in the ships being "run under the waves." Of the Holmes vessels engaged in the trade, four were lost in this manner.

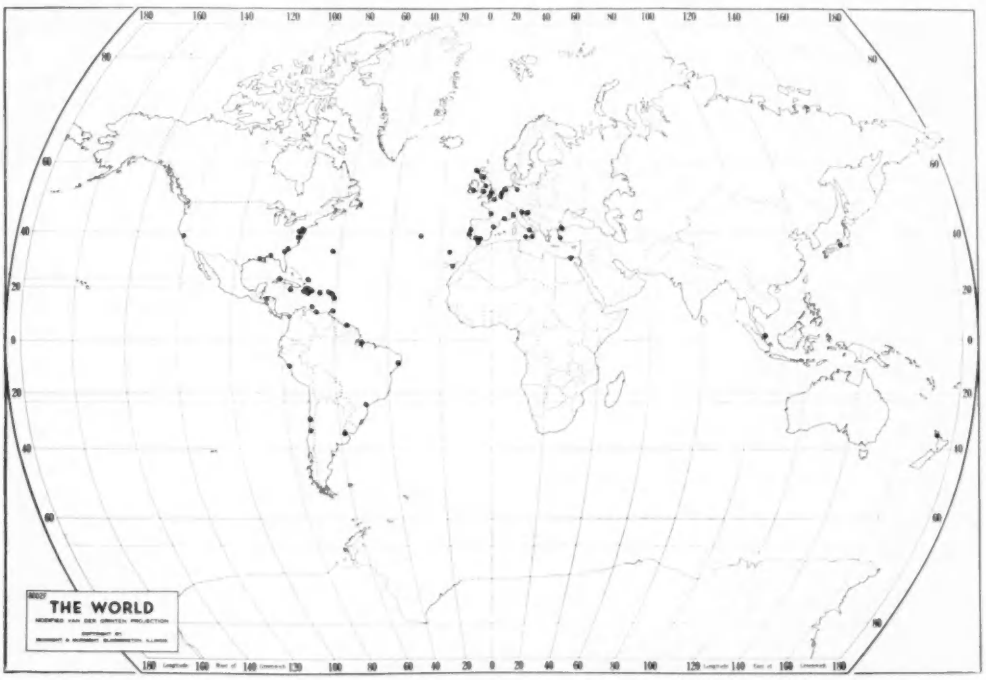

FIGURE 10.—Ports of call of the Holmes vessels out of Kingston, illustrating the principal areas of trade of southeastern Massachusetts. The vessels participated in the lucrative "triangular trade" between New England, the Caribbean, and western Europe.

Among the limited number of commodities in the Caribbean trade were dried, salted, and refuse fish, and following 1840, ice. The return cargo consisted of salt, sugar, molasses, a few slaves, and some fruits.

A triangular trade existed between Massachusetts, the Atlantic and Gulf ports, the West Indies, and northwestern Europe. Ships went to southern ports with New England products or in ballast, where they obtained cotton, tobacco, lumber, or sugar from the West Indies, to be exchanged in England or the continent for coal, iron, nails, canvas, duck, Russian hemp (*Cannabis sativa L.*), and manufactured goods. Around 1832 Plymouth was the point of import for bar iron which served the 26 establishments engaged in iron manufacture in Plymouth County. In 1803 the foreign trade of the Plymouth Customs District was carried by 17 ships, 16 brigs, and 40 schooners. The duties paid on the cargoes were about $100,000.

Fishing was long a highly important occupation in most seaboard towns. Many of the vessels built here entered that trade in the summer and made about three trips to the banks between March and November, then went on trading voyages, called "freighting voy-

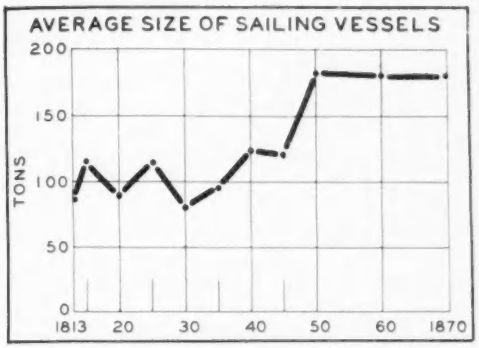

FIGURE 11.—Shipbuilding rose to its peak in the period when sailing vessels averaged about 100 tons. The industry declined precipitously after 1840 when vessels increased in size beyond the limit of the yards' maximum.

ages," south in the winter. The ships brought home corn, flour, coal, and lumber, timing their arrival to coincide with the outfitting season for the banks fisheries. This continuous employment which produced a steady income for the ship owner and builder, was a factor of considerable importance in the demand for vessels.

During the colonial period and the early years of the United States, while maritime interests were dominant, many protective laws were passed favoring the owners, builders, and merchants. As early as 1641 the General Court of the Massachusetts Bay Colony passed a law as follows: "Whereas the country is now in hand with the building of ships, which is a business of great importance for the common good, and therefore suitable care is to be taken that it be well performed; it is therefore ordered that when any ship is to be built within this jurisdiction it shall be lawful for the owners to appoint and put in some able man to survey the work and workmen from time to time, to see that it be performed and carried on according to the rules of their art." The first of the English Navigation Laws were actually helpful to the colonies. An act in 1650 provided that nothing produced in Asia, Africa, or America should be imported into any part of the British Empire except in English ships. This law succeeded in eliminating the Dutch from competition in the American trade. It aided building in America until 1663 when more adverse laws were passed.

During Washington's and Adams' administrations, government measures were especially helpful. Duties on all imports were very low, being tariffs "for revenue only." Preferential rates were granted American vessels in proportion to the distance from which they brought goods to the country. Tariffs were returned on all goods re-exported within one year of importation. In 1791 the bonded warehouse system was established by Hamilton. It allowed tea duties to be paid any time within two years of importation, thus giving the merchants a chance to sell their tea before the tax fell due. In 1795 this system was extended to other products from Europe and the West Indies. In 1790 a port fee of 50 cents per ton was levied on all foreign vessels. American vessels paid only 6 cents per ton, and those in the coasting trade paid this fee only once a year, while foreign ships paid it in every port of entry. In 1785

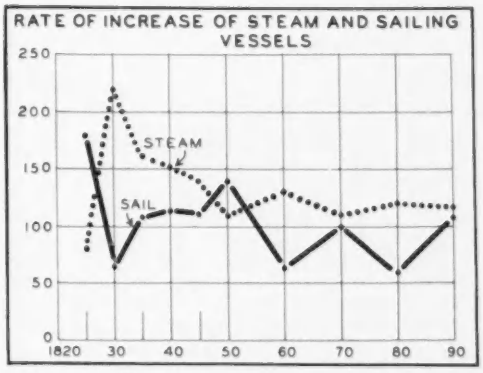

FIGURE 12.—Comparative rates of increase of steam and sailing vessels in per cent, 1825–1890. The advent of the iron steamer sounded the death knell of the wooden sailing ship, an effect which was first felt in southern New England.

Congress levied duties for the purpose of encouraging shipbuilding based upon the use of American materials only. Six cents per gallon was paid on rum imported in foreign vessels, and 7s, 6d per ton on every vessel entering from a foreign country. Specific countries which had reciprocal trade treaties with the United States were excepted. Ready-made sails paid a ten per cent duty, blocks and sheaves 7½ per cent. All tea imported from Europe paid from 6d to 2d per pound, depending upon quality. This had the effect of establishing a direct trade with Asia, as direct importations were duty free.

DECLINE OF SHIPBUILDING

Following the peak of development reached in 1840, two classes of factors were responsible for the decline of building in this region. The first group may be classed as local. Perhaps the most important single factor militating against the industry was the steadily increasing size of American sailing vessels (Figure 11). Throughout the district the maximum size of vessels which could be economically built and launched was well under 500 tons. Although it was possible to build somewhat larger vessels, it became increasingly expensive to build, launch, and get them to sea. At North River it cost $1000 to get the 390 ton "Hilo" to sea from one of the yards up river. The largest ship ever built on the river was only 464 tons. Another contributing condition was the exhaustion of the local timber supply. At first the failing local supplies could be supplemented by oak from the surrounding towns which were within reasonable hauling distance, but when it became necessary to import lumber from more distant sources, it was economically impossible to compete with more favorably located builders.

FIGURE 13.—The townspeople along North River, proud of their former great industry, have erected markers at the sites of the old yards. Such a marker here clearly shows excellent locational advantages on a meander.

Thus the area was replaced in prominence by the Boston Bay region which had better access to raw materials and deeper water. The northward migration of the industry was materially aided by the builders themselves, many of whom left southeastern Massachusetts, and started new yards at Medford and Boston.

Another factor of local importance was the removal of the fishing bounty which had formerly stimulated the Plymouth Bay fishing fleets, and had indirectly provided a demand for fishing craft. Steady concentration of fishing interests at Gloucester and Provincetown further affected the industry.

Besides such local conditions adversely affecting the industry, a complex of regional and national factors indirectly undermined the structure of the building business. Some chief factors may be briefly mentioned. The industrial revolution in New England was financed largely by transferred maritime capital. C. F. Jones states that it was the most important single source of early industrial capital. Even when industry became well established, the opening of the west by railroads attracted both labor and capital that otherwise would have been available to maritime interests. Two financial panics, one in 1837, the other in 1857 took considerable toll of shipbuilding firms, many of whom never were able to resume operations. Competition of steam with sail was a factor of considerable consequence in the decline of wooden sailing vessels. The chart (Figure 12) shows that following 1830, steam driven ships increased in number at a faster rate than sailing ships. The single exception was the year 1850 when the demand for all types of vessels rose unusually high.

The decline of the carrying trade of

FIGURE 14.—This picture, taken about 1890, shows the last vestiges of the five forges formerly located in Hanover on the upper reaches of North River.

FIGURE 15.—This illustration shows the location of numerous yards at a point at North River below the bridge shown in Figure 16, combining the essential requirements mentioned in the text.

the United States had disastrously affected shipbuilding. Until 1830, an average of about 90 per cent of the foreign trade of the country was carried in American-built vessels. In 1879 the figure had dropped to 23 per cent. Reciprocity treaties with Britain proved ruinous to American maritime interests. Prior to 1831 an average of only 76,500 tons of English ships entered American ports each year. The average for the decade 1831 to 1840 was 212,600 tons per year, an increase of 278 per cent. By 1849 British vessels could enter any port in the United States on absolutely equal terms with American vessels. With decline of the foreign carrying trade, American ships retreated to the heavily protected coastwise trade, but here again, they lost business steadily to the rapidly expanding eastern railroad networks. Later, with completion of the transcontinental lines, the lucrative California and west coast trade was largely lost.

The cumulative effect of these factors was the precipitous decline of shipbuilding in southeastern Massachusetts (Figure 4), and an exodus of part of the building population to more northerly centers which were being established. Thus is epitomized the beginning, rise, and decline of one of the significant industries of early southeastern Massachusetts, an industry which formed the foundation for the essential economic activities of the region.

SHIPBUILDING ON NORTH RIVER: A TYPE STUDY

The most intensively developed center in this region was North River, of which the valley was a virtually self-contained shipbuilding unit. In this basin the industry grew and prospered. The workmen became so skilled that, with the decline of the river yards, the valley became a center of dispersion for ship carpenters who emigrated and established some of the leading shipyards of the later periods in northern Massachusetts.

Shipbuilding on North River was materially aided by some of the natural characteristics of the valley. The meanders of the stream in its lower course provided excellent sites for yards

(Figure 13). Because the river was narrow, it was necessary to locate the yards on the curves of the meanders, facing either up or down stream so that in launching ships they would not be damaged by striking the opposite bank. The average tide penetrated more than six miles upstream, and gave opportunity for the construction of much larger vessels than would be possible without such tidal rise of several feet (Figure 3). The sources of the river are in glacial lakes in which a good grade of bog ore was found, and the upper courses had sufficient gradient for the establishment of power sites for forges and lumber mills. Because of the availability of both ore and power, numerous forges were located within the drainage basin of the North River (Figure 3). Most of the enterprises manufactured anchors for the vessels built on the river; some anchors were even sold in Boston and Salem. The anchors for the famous frigate "Constitution" were made here. The first forge was established in 1702 at Furnace Pond (Figure 3), while the last one to be in operation went out of business about 1880 (Figure 14). Besides anchors, the forges supplied iron "knees" and ship fittings to the builders. They were mostly small affairs, the largest made an average of 250 tons of anchors per year, ranging in size from one-half to two tons. Sixteen men were normally employed. During the Revolution and the War of 1812 most of them turned to the more profitable manufacture of cannon.

FIGURE 17.—The old Boston-Plymouth road passing over North River Bridge. Building sites were on the downstream side of the bridge. Supplies were brought over this road from Boston and Plymouth.

The North River basin was unusually well supplied with white oak, so much so, that in some cases vessels were constructed entirely of the heartwood. In colonial New England, oak was the standby of the shipbuilding industry. The old records show few examples of the early builders here complaining of a paucity of local timber, and lumber shortage was not a significant factor in the decline of the river yards until the later stages, when they were already doomed by other conditions. With the development of the business between 1800 and 1840, it proved necessary to import wood, but imports were kept at a minimum.

Materials other than lumber and iron were usually imported in finished or semi-finished form. Rope rigging was always obtainable in Boston, but after 1824 it was available in nearby Plymouth, where the Plymouth Cordage Company was established, a business still

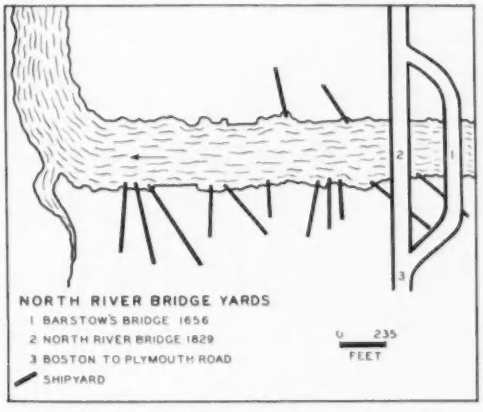

FIGURE 16.—This map shows the densest concentration of shipyards in southeastern Massachusetts. There were twelve firms and thirteen yards located in this limited area.

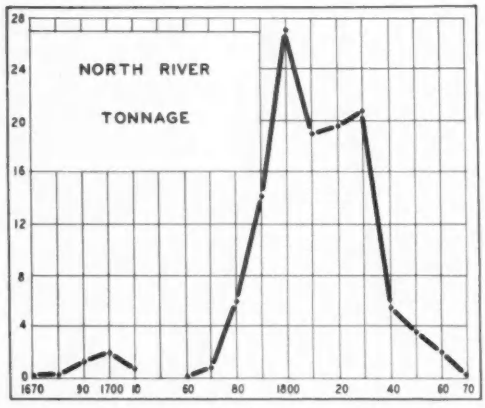

FIGURE 18.—Production of vessels on North River in thousands of tons by decades. North River had a sharply defined peak of activity, building 26,000 tons of ships during the decade 1790–1800.

in operation today, and one of the largest plants of its kind. Canvas sails were usually bought completely made to each ship's specifications. This phase of the industry was usually considered apart from the actual building, and almost always was done by a firm other than the one that built the ship. Some of the iron and other metallic fittings were also imported from Boston.

Shipbuilding yards were extremely simple in organization and equipment. A piece of level land free from marsh, bordering on deep water, a place to pile lumber, and one or two rough sheds in which to keep plans, and perishable materials and tools completed the essentials (Figure 15). Except for derricks and large heavy implements, the workers were expected to furnish their own tools. By reason of such simplicity of requirements, the yards had no difficulty in finding adequate accommodations on the meanders along the six miles of the river to which the tide penetrated. Of the total of thirty yards on the river, a concentration of twelve firms was located on the downstream side of the old North River Bridge, over which the Boston to Plymouth road passed (Figures 16 and 17). The reason for the premium put upon this area was that supplies coming

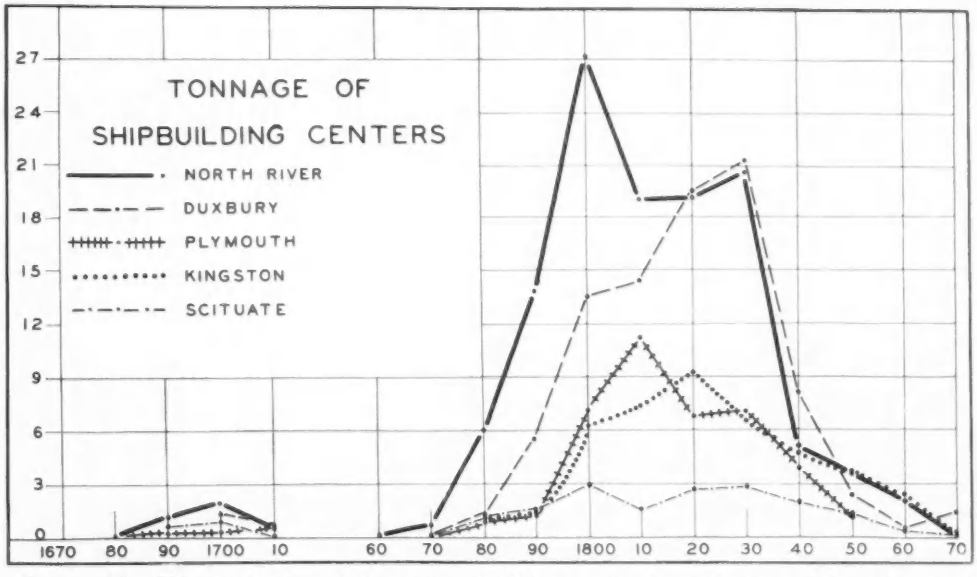

FIGURE 19.—Ship production of the various building centers in southeastern Massachusetts in thousands of tons. There was a migration within the area, of the peak of activity, the chief centers arriving at their peak in the following order: North River, Plymouth, Kingston, and Duxbury. Access to the open ocean at Duxbury permitted it to reach its peak at a later date than the other centers. The inland location of the North River yards forced the peak of production to be reached earlier than any of the other centers.

from Boston travelled over this road by wagons. As no ships could navigate the river, these yards received supplies most easily, roads to the other sites being little more than rough trails.

Largely on the basis of these natural advantages, the river yards grew and prospered. As will be pointed out, they also declined because of factors inherent in the natural environment. Although building began as early as 1678, and did not entirely cease until 1879, the period of significant activity in which North River was one of the major producers of New England was between 1790 and 1850 (Figure 18).

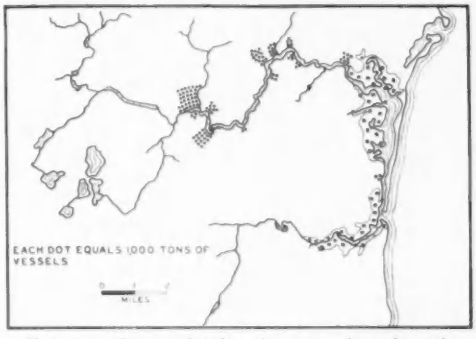

FIGURE 20.—Distribution of North River tonnage built during the entire life of the industry. Note the concentration of dots far upstream, attesting to the productiveness of the yards grouped near the North River Bridge.

Considered from the viewpoint of total tonnage, and number of vessels, the river was the largest builder of ships in southeastern Massachusetts, the all-time figure being over 122,936 tons. Duxbury was next with 88,937. The peak of production was reached in the decade 1800 to 1809 when 27,190 tons of ships were built (Figure 19).

Although important building sites were located at many points on the river, the area of heaviest production was at the North River Bridge in the town of Hanover, where a total of 33,887 tons of vessels was built, over one-quarter of the total tonnage for all the sites along the river. The map (Figure 20) shows the relative amount and distribution of production.

Practically all North River vessels were constructed for three main markets. Boston and Salem merchants employed them in the European, Asiatic, and coasting trades. Nantucket and New Bedford whalers used them in large numbers. Massachusetts fishermen employed them in the banks fisheries.

In 1773 James Briggs constructed the famous ship "Columbia" of 212 tons in his yard (Figure 21). This vessel was the first American ship to circumnavigate the globe, and, of more importance, it discovered and explored the Columbia River. The little vessel entered the river in September, 1791, and remained until May, 1792 during which time the crew built a fort and a small boat. It is this event that formed a significant part of the bases for the American claims to the Oregon territory.

The most efficient vessel constructed by the builders was a ship or brig of between 200 and 350 tons; this size range predominated throughout the period of greatest activity. It cost about one dollar per ton to get such a ship out to sea, but the cost rose rapidly beyond this upper limit, thus severely limiting the size of vessels it was economically possible to build here.

Without doubt the most important factor in the decline of the river yards was the increase in size of ships demanded by the merchants in the 19th century era of expanding trade (Figure 11). The process of getting a ship from one of the up-river yards to the sea was often quite complicated and expensive. Launching was always at high tide. Then, with numerous empty barrels lashed at low tide to the hull for buoyancy, and with two guy-ropes to each bank to keep the vessel in the narrow channel, it was towed downstream to the mouth. Once there, the

NORTH RIVER
BETWEEN 1670 & 1871
MORE THAN 1000 VESSELS OF FROM 30 TO 470 TONS WERE BUILT
OF THESE IN 1772 ICHABOD THOMAS CONSTRUCTED THE SHIP BEAVER
AND THE BRIG BEAVER. THE FORMER WAS THE FIRST VESSEL
TO DISPLAY THE UNITED STATES FLAG IN EUROPEAN WATER
OFF TRINITY ENGLAND FEB. 6 1765. THE LATTER WAS ONE OF THE
FAMOUS TEA SHIPS OF BOSTON HARBOR
THE SHIP COLUMBIA 212 TONS
MOUNTING 10 GUNS BUILT BY JAMES BRIGGS IN 1773 WAS THE
FIRST U. S. VESSEL TO CIRCUMNAVIGATE THE GLOBE
IN 1792 HER CAPTAIN ROBERT GRAY DISCOVERED
THE COLUMBIA RIVER AND IT WAS
FROM THIS VESSEL THAT THE RIVER
RECEIVED ITS NAME

FIGURE 21.—This marker is a reminder of the old "Yankee enterprise" which expressed itself in the development of a great shipbuilding industry. Yankee ships established American trade in ports throughout the world, and were an important factor in the establishment of American territorial claims on the west coast and in the Pacific.

problem became really serious, for the bar effectively blocked the way to the sea (Figure 3). To get the larger ones to deep water, it was necessary at low tide to dig a deep ditch through the bar, then on the tidal flat beyond the bar, to bury large planks five to six feet deep in the sand, to which heavy chains were fastened. The chains were then attached to the windlass of the ship, and scows were lashed under the bow and stern to give added buoyancy. Now with as many as fifteen men straining on the windlass, aided by one or more high tides, the vessel would be half dragged, half floated over the bar. This process was called "kedging," and the details of its operation give an excellent example of some of the difficulties under which the industry was carried on, and how strictly the size of North River vessels was limited. It also explains why no ship ever returned after once passing over the obstruction.

As competition increased, the chances for the survival of the river yards obviously depended upon the removal of the bar. The builders realized this; in 1841 they made an attempt to have the national government dredge a channel through the bar. John Quincy Adams, then a member of Congress was shown the shipbuilders' proposal, inspected the river, and declared himself favorably impressed. Nothing ever came of the project, and the industry here was doomed. It had begun, expanded, flourished for a time as it realized the maximum benefits of its natural environment, and then, with the economic requirements changing, the inherent disadvantages became effective, and the industry disappeared. Today, a lone boat-repair and storage yard at the site of the old Brick Kiln yard is the only reminder of the once flourishing industry of shipbuilding on North River.

BARROW IN FURNESS: A POPULATION STUDY

T. H. Bainbridge

IN the Memorandum on the Geographical Factors Relevant to the location of Industry it is stated that "the geographical factors relevant to the location of industry are of two kinds: (1) those strictly physical, as for example surface configuration, location of minerals and existence of underground water supplies; and (2) those due in whole or part to human agency, as for example the distribution of the railway network, of docks and canals." It would be difficult to find any town in the British Isles, with the possible exception of Middlesbrough, which so clearly supports these statements as does the Lancashire borough, Barrow-in-Furness (Figure 1).

Two large volumes were published in 1769 entitled "England Displayed" and among the twenty-seven market towns of Lancashire which were mentioned four were in Furness viz., Hawkshead, Cartmel, Ulverston, and Dalton but there is no mention of any place called Barrow. This is not surprising for it was only a hamlet in the township of Hawcoat which formed part of the parish of Dalton (Figure 1).

This village situated on the coast of Low Furness was said to consist of seventeen houses in 1845 inhabited by not more than 68 persons. This number increased rapidly because in the following year the construction of the Furness Railway made possible transport of iron ore from the inland deposits. The number of iron ore miners in Furness increased from 471 in 1851 to 3,597 in 1874. The increase of trade in turn resulted in 1848 from an Act for maintaining and improving the harbor. Between 1851 and 1861 the population of the parish of Dalton (which contained Barrow) was nearly doubled.

TABLE I

POPULATION OF DALTON IN FURNESS, 1801–1861

1801	*1811*	*1821*	*1831*	*1841*	*1851*	*1861*
1,954	2,074	2,446	2,697	3,231	4,683	9,152

This decade was notable for several facts. In 1851 the number of vessels entering and clearing was about 1,900 and the total quantity of iron ore, copper ore, and slate handled was upwards of 160,000 tons. The first ship built at Barrow, the "Jane Roper," was launched in 1852. Five years later the Furness Railway had been extended to join the Lancaster and Carlisle Railway, and 1859 was marked by the opening of the Park Iron Ore Mine and the erection of two furnaces for the smelting of iron ore at Hindpool, now in Barrow; an additional five following three years later. From beneath an area of one acre, one and a quarter million tons of ore have been obtained and upon this output a royalty of 80,000 pounds has been paid, being equivalent to a surface value of more than 16 pounds per square yard.

The production of steel began in 1865 and two years later a highly important event was the construction of the large Devonshire and Buccleuch Docks. This same year, 1867, witnessed the real beginning of Barrow as a separate entity, incorporation as a Borough becoming an accomplished fact, and by 1871 the census returns showed Barrow as a separate civil parish with a population of 18,584.

TABLE II

BARROW IN FURNESS: POPULATION, 1871–1931

Year	*1871*	*1881*	*1891*	*1901*	*1911*	*1921*	*1931*
Population	18,584	47,259	51,712	57,586	63,770	74,244	66,366
Per Cent of Increase or Decrease	.....	+154.8	+9.4	+11.4	+10.7	+16.4	−10.8

A glance at the above population returns reveals at once the fact that the decade 1871–81 was the period when Barrow grew with amazing rapidity. Unfortunately however, it is impossible to obtain information as to where the people came from as in 1881 birthplaces were only recorded for Urban Sanitary Districts where the population was greater than 50,000.

It is possible to obtain some idea as to the birthplaces of those resident in the borough at the beginning of the present century. From the following table it can be seen, among other facts, that less than sixty per cent were natives of the county of Lancashire.

TABLE III

BIRTHPLACES: BARROW IN FURNESS, 1901

Males 31,494 Females 26,092 Total 57,586

	Per Cent	*Per Cent*
N. W. Counties	....	59.7
Lancashire	58.6	.....
Cheshire	1.1	.....
N. Counties	..	8.6
Cumberland	4.9	.....
Westmorland	1.7	.....
Durham	1.1	.....
Northumberland	0.9	.....
West Midland Counties	....	7.4
Staffordshire	4.2	.....
Scotland	....	6.2
Ireland	....	4.6
Yorkshire	....	3.5
Wales and Monmouth	....	0.97

FIGURE 1.—Geographical Location of Barrow-in-Furness. 1 Devonshire Dock; 2 Buccleuch Dock; 3 Cavendish Dock; 4 Ramsden Dock, with timber dock and oil depot; 5 Engineering Works and Ship-building Yard of Vickers-Armstrongs, Ltd., on Barrow Island; 6 Barrow Hematite Steel Co., Ltd.

When the 1911 figures are examined it is evident that Barrow was the English County Borough with the greatest proportion of Scotch born inhabitants, followed, it is of interest to notice, by Newcastle on Tyne. It is worth noting also that although a seaport there are no foreign quarters in the town.

An examination of the figures in Table II fails to give a true picture of conditions in Barrow. After the amazingly rapid growth in the "seventies" which caused it to be hailed, rather too quickly, as "The English Chicago," there were signs that even at that early stage in its industrial history the normal employment capacity of the local industries was being taxed by the increasing occupiable population. On closer examination therefore (see Table IV) we find that even in the decade 1881–91 there was a movement of people away from Barrow, although this is not evident in Table II because of the relatively high

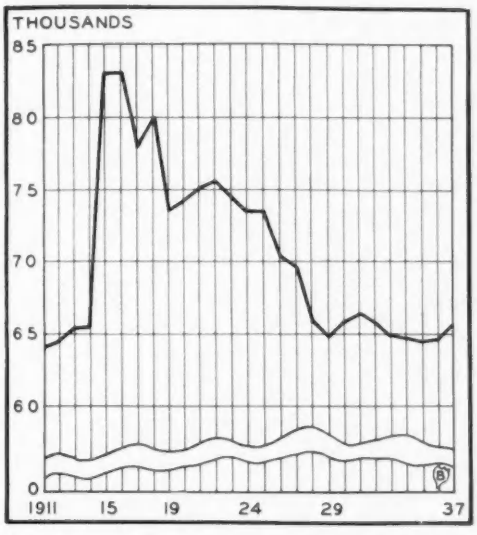

FIGURE 2.—Population of Barrow-in-Furness, 1911–1937. (Based on the estimated population for each of the years 1911 to 1937 as given in The Registrar General's Statistical Review of England and Wales.)

rate of natural increase which was such as to bring about an actual, and substantial increase of population until 1921. It would be of interest to know the destination of the 23,859 who have migrated in the last fifty years and to wish that some diversification and stabilization of industry had made it possible for them to remain.

TABLE IV

POPULATION CHANGES: BARROW IN FURNESS, 1881–1931

Year	Population	Per Cent Increase or Decrease	Excess of Births Over Deaths		Gain or Loss By Migration	
			No.	Per Cent	No.	Per Cent
1881	47,259	.....	.....	....	.....	.....
1891	51,712	+ 9.4	10,154	21.5	- 5,701	-12.1
1901	57,586	+11.4	8,411	16.3	- 2,537	- 4.9
1911	63,770	+10.7	9,778	17.0	- 3,594	- 6.3
1921	74,244	+16.4	9,981	15.7	+ 493	+ 0.7
1931	66,366	-10.8	4,009	5.4	-12,027	-16.2

The variability and fluctuations of population in towns which owe their location and existence essentially to mineral wealth are well known, but even so, a more detailed study of the changes in Barrow during the last quarter of a century is worth attempting. This is best done by studying the annual returns of the Registrar General in the Statistical Review of England and Wales.

Before doing so it will be as well to look at the chief occupational groups in Table V.

TABLE V

OCCUPATIONS OF MALES, AGED 12 YEARS AND OVER: BARROW IN FURNESS, 1921

		Per Cent
Metal workers	11,043	42.8
General laborers	2,416	9.4
Transport workers	2,029	7.9
Commercial workers	1,422	5.5
Clerks and draughtsmen	1,287	5.0
Wood workers	1,109	4.3
Builders	724	2.8
Builders of ships and boats	598	2.3
Others (electricians, painters, etc.)	5,171	20.0
	25,799	100.0

1921 chosen in preference to 1931 because of the greater population.

One glance at the table is sufficient to indicate that Barrow still depends for its existence upon metal working, despite the fact that while in 1855 some 64 per cent of the total output of ore in Cumbria was mined in Furness only 15.4 per cent of the total was obtained in this region in 1930. Of the metal workers 2,313 were fitters and millwrights, 1,862 boiler makers, 646 riveters and 202 riveters' laborers, while 931 foundry workers and 154 furnacemen were included. More than 40 per cent of the men therefore find employment in engineering, in shipbuilding, and in the manufacturing of iron and steel. The first two of these occupy the bulk of the workers and so the destinies of the people of Barrow depend largely upon one great concern, Vickers-Armstrongs, Ltd.

These trades are notorious for their fluctuations of which the annual returns provide abundant evidence. These yearly population estimates (hence differences in figures for census years)

shed light on the conditions during the war years (see Figure 2). One can hardly imagine the internal state of affairs in a town which added 16,880 people in one year, only to lose them in the years following, especially of course in 1919. The diagram (Figure 3) indicating the gain or loss by migration between 1911 and 1937 is really an economic barometer.

Barrow is 83rd among the 113 large towns of the country and is characterized by several interesting facts. First as would be expected in a "steel town" the males exceed the females and the ratio of male to female employment is low, being four to one which compares unfavorably with, say, Carlisle where the ratio is two to one. The town is exceptional in having a comparatively large population associated with a low acreage density. The average density is six persons per acre (area 11,002 acres, population 66,366). Even the 98.8 persons per acre in the Central Ward (see Figure 4) is greatly exceeded in the larger cities, as for instance in Liverpool where in the Netherfield ward the density is 226.8 per acre.

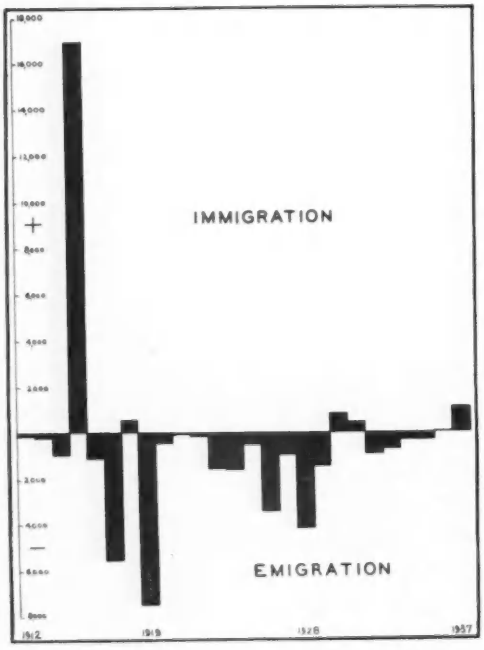

FIGURE 3.—Balance of migration in Barrow-in-Furness, 1912–1937. (Based on The Registrar General's Statistical Review of England and Wales, for each of the years 1911 to 1937.)

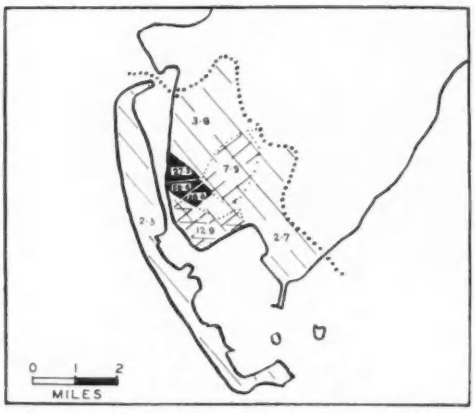

FIGURE 4.—Density of population of Barrow-in-Furness by wards, 1931.

In this brief study we have seen how this well-planned and unique town owes its very existence and growth essentially to mineral wealth. Because of this however, growth has been irregular and it has the unhappy experience of showing in the 1921–31 period the third largest decrease of population (–10.8%) being exceeded only by Rhondda–13.1 and Merthyr Tydfil with –11.3%. It is interesting to notice that although Barrow began its "mushroom growth" before its eastern counterpart, Middlesbrough, yet the latter is now much more populous (138,489—1931) presumably because of its proximity not only to ore and the coast but also to fuel. All fuel used in Barrow has to be brought by rail, from Durham, Yorkshire (Barnsley district), and Lancashire, with a little also from West Cumberland. Much foreign ore is also imported, although this is not the chief import, for in point of value it is preceded by petroleum and timber. Much of the timber is used in the Barrow Paper Mills situated near the Cavendish

Dock, while the petroleum is distributed throughout the northwest of England.

This port and county borough "in its own self-contained corner in the Northwest of England," which less than a hundred years ago was little more than a hamlet, owes its existence and growth as we have seen "as much to the activities of man as to the blessings of nature." (Barrow-in-Furness: Commercially Considered The Barrow-in-Furness Corporation, 1931.)

EUROPE'S FUEL AND METAL DEPOSITS EVALUATED

Quentin D. Singewald

POLITICAL events have focused attention on the mineral wealth of certain countries and groups of countries in Europe. Although statistics for current production and consumption are readily available, these give only the immediate picture, which now is particularly distorted through trade and currency manipulations. The long range picture of mineral wealth can be obtained only on the basis of resources, for which information is less tangible. A recent six-month tour, during which the writer visited nearly all important mining districts of Europe except those of England, Spain, Italy, and Greece, provided, among other data, opportunity to acquire up-to-date information on reserves and on geologic probabilities for additional extensions. By using this personal information to supplement data obtained from many domestic and foreign publications, the writer has evaluated into different categories of importance the districts represented on Figure 1.

In order to avoid its becoming cumbersome, this article confines itself to mineral commodities having greatest strategic importance to industrial development, especially the heavy industries. The mineral fuels and iron ore, obviously, have greatest significance. Next come copper, lead, and zinc. Then come the principal "lesser metals," aluminum, tin, and the ferro-alloys. Less important industrial metals and the precious metals are omitted. All the non-metallic minerals are likewise omitted even potash and others whose world geographic distribution may be restricted.

Coal—Bituminous and Anthracite

General Distribution:—Europe, considered as a whole, possesses coal reserves easily capable of maintaining present production far into the future without fear of exhaustion. The rate of depletion, nevertheless, is considerably more rapid than the average for the world, since the continent possesses only one-sixth of the reserves, yet produces and consumes one-half the world total.

The bulk of the reserves are concentrated in four general regions. England, Wales, and Scotland possess more than a quarter; western Germany, Belgium, Holland, and eastern France more than a third; eastern Germany and southwestern Poland a fifth; and the Ukraine a tenth of Europe's aggregate. Almost all the remainder, less than a tenth of the whole, are in Spain, the Ural Mountains, and Bohemia. It will be immediately apparent that the four principal regions correspond closely though by no means precisely with regions of greatest industrial development, a relationship likely to be maintained in the future.

Individual coal fields may conveniently be divided into four categories of importance, here labeled as "outstanding," "major," "minor," and "trivial." Those in the first three categories are depicted in Figure 1. It is particularly significant that all outstanding and major fields lie within the four principal regions noted above.

Outstanding Fields:—Two fields, the Ruhr and Silesia, exceed all others in importance. Each possesses more than 2.5 per cent of the world reserves, or, in

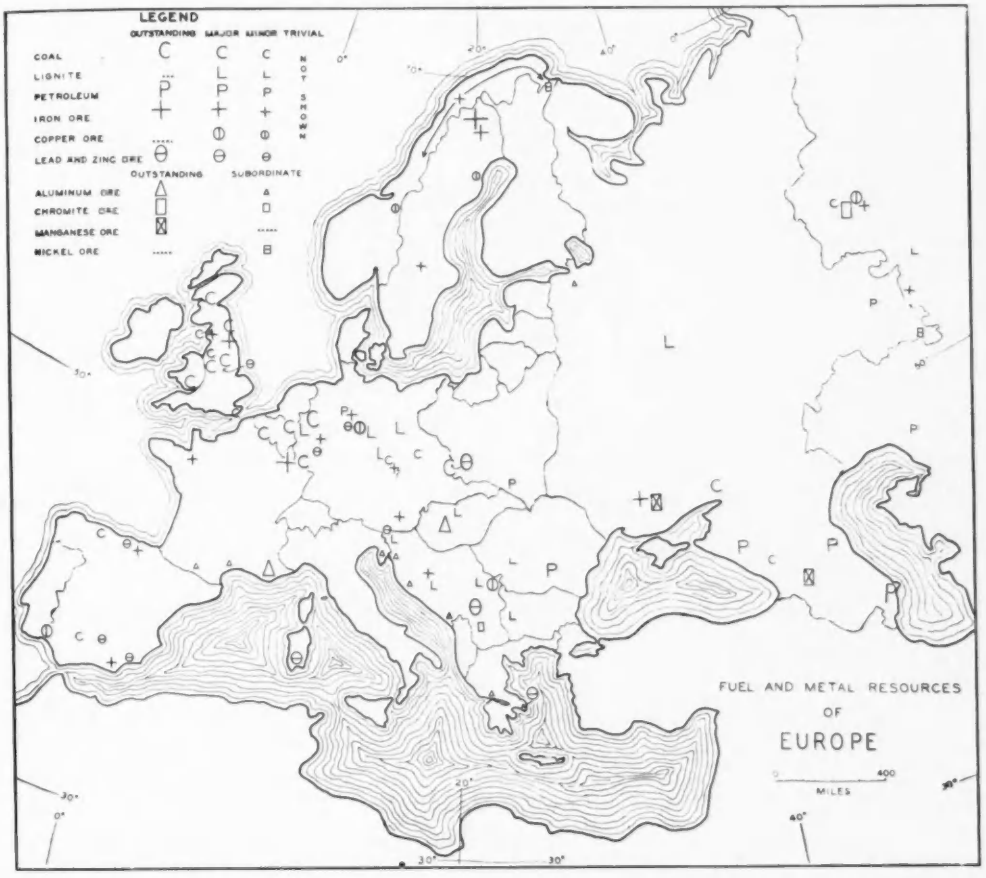

FIGURE 1.—Fuel and metal resources of Europe. Mining localities mentioned in text are represented on this map by symbols, whose relative sizes indicate categories of importance.

terms of tonnage, more than 100 billion tons of known and potential coal in seams more than a foot thick and less than, 4000 feet deep. They are equaled or surpassed by only five other fields in the world. Alone and with no undue strain, each would be capable of meeting the entire needs of a heavily industrialized region of major proportions. Although the thickness and accessibility of seams in the Silesian field are slightly superior to those in the Ruhr, the quantity of coal suitable for metallurgical coke in the Ruhr greatly surpasses that of any other European area.

The Ruhr lies entirely within Germany, in its northwestern part. Silesia, on the contrary, is now divided between Poland and Germany, the former having a predominant share. As used in this paper, Silesia includes the so-called Dombrova and Cracow fields, for all are parts of a continuous basin; the individual names originated because of political boundaries prior to the World War, but there actually is some difference in the character of coal in each subdivision.

Major Fields:—Fields classed as "major" possess from one-fourth to two per cent of the world's reserves, that is, from approximately 10 billion to decidedly less than 100 billion tons. Thus, there is considerable range in size. An average

one would be capable of contributing a large share but not the entire requirements of a region whose industrial development had reached major proportions.

In their order of importance, according to magnitude of reserves, the "major" fields of Europe are:

Name	*Location*
Donetz	Ukraine
Yorkshire-Derbyshire-Nottinghamshire	England
South Wales	Wales
Scottish Fields	Scotland
Saar	Germany
Newcastle	England
Aachen-Campine, et al.	Mainly in Belgium, subordinately in Holland; with slight amount in Germany
Valenciennes-Namur	Northeastern France across southern Belgium. Three-fourths in France
Staffordshire	England

Minor Fields:—The "minor" fields possess from slightly under a billion to nearly 10 billion tons of reserves. None could provide a large share of the requirements in any region of even modest industrial development. Each, however, is or could be a contributor worthy of some recognition.

Great Britain has seven fields belonging to this category. Three of them—Cumberland, Lancashire, and Kent—are indicated separately on Figure 1. The remainder—North Wales, Leicestershire, Warwickshire, and Bristol-Somerset—lie too close to other, major, fields to be shown without confusing the map; consequently, they may be considered as included diagrammatically with the larger fields.

In northwest Spain, a group of fields located in the general vicinity of Oviedo but actually covering parts of several provinces are represented on Figure 1 by a single symbol. Of considerably less importance are another group, likewise represented by one symbol, in the southern part. Still smaller deposits

FIGURE 2.—Albert Shaft, near Kalinovskoye, Donetz Basin.

scattered at different localities are not shown.

In the Bohemian area are two symbols. One represents Lower Silesia, the other the Kladno and Pilsen areas jointly. The Kladno-Pilsen fields, west of Prague, have the smallest reserves of any shown on the map.

Two minor fields are indicated for European U.S.S.R. One in the Ural Mountains represents a composite of a larger and several smaller in close proximity. The symbol in the Caucasus Mountains likewise represents a group.

LIGNITE—BROWN AND BLACK

Production and General Distribution:—With scarcely 3 per cent of the lignite reserves, Europe produces about nine-tenths the entire world output. The reasons are diverse. Germany, which accounts for the bulk of both production and reserves, mines lignite primarily because of unusually favorable conditions as to accessibility and thickness of seams. These factors permit large-scale, mechanized production at low cost, as evidenced by the highest output per man per day in the world. Former Czechoslovakia, whose production ranked second in the world yet was only one-tenth that of Germany, required lignite to supplement inadequate bituminous coal resources. The somewhat

smaller production of the Soviet Union is chiefly for local consumption at places devoid of higher rank coal. Most of the remaining production comes from the block of countries constituting south-central Europe. They require relatively little coal, but as bituminous reserves are trivial, even small demands must be met by coal of inferior rank.

Lignite fields may conveniently be classified into categories of importance on the same basis as was used for bituminous, inasmuch as world reserves of each are of the same general order of magnitude, namely, several thousand billion tons. Since the largest field in Europe has total known and potential reserves amounting to no more than 30 billion tons, none may be classed as outstanding. There are, however, five fields having greater than ten billion tons, and seven having between one and ten billion tons of reserves.

Major Fields:—The "major" lignite areas of Europe listed in probable order of reserves are:

Name	*Location*
Lausitz–East Germany	Eastern Germany
Halle-Leipsig	Central Germany
Cologne	Western Germany
Moscow	Soviet Union
Most-Falknov	Bohemia

Some of these actually are composites of several fields represented by a single symbol on Figure 1. Moreover, it may be noted that the Bohemian fields, even considered as a unit, are border-line and could just as well be included among the minor fields.

Minor Fields:—Jugoslavia, with larger reserves than any country south of former Czechoslovakia, has three main lignite areas, each represented by a symbol on Figure 1. One is in the extreme northwest, another near Sarajevo, and the third southeast of Belgrade. Scattered fields of trivial importance occur elsewhere.

Bulgaria, Roumania, and Hungary possess lignite fields at scattered localities; the most important center in each country is indicated on Figure 1. In the eastern Urals, the principal deposits are near Cheliabinsk.

Trivial deposits, smaller than any shown on the map, occur scattered in almost every country except those in the extreme north.

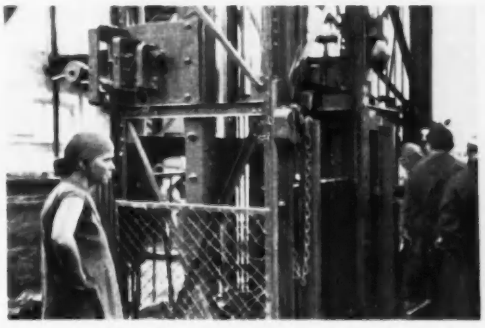

FIGURE 3.—Woman miner at shaft in Donetz Basin.

PETROLEUM

Preliminary Statement:—Petroleum resources must be evaluated by a different method of approach than coal or lignite. The real future of any area depends much more on the undiscovered than upon the known reserves. Consequently, it becomes necessary for each province to correlate the present status of production and reserves with geological considerations as to whether the production is likely to be maintained, increased, or decreased. Such estimates, obviously, can apply only to the relatively near future.

Outstanding Fields:—Only one European area can be classed as having outstanding world importance. It is Baku, located by the Caspian Sea east of the Caucasus Mountains. This region, which includes several of the world's largest

individual fields as well as smaller ones, has yielded about 10 per cent of the aggregate, and now accounts for 8 per cent of the annual production from the world. During recent years production has been greatly increased by extensions and new discoveries, and no evidence suggests that the peak has yet been reached. Consequently, it may be expected to maintain a prominent position for at least some years.

FIGURE 4.—Huge shovel in lignite pit near Halle, central Germany.

Major Areas:—Three areas have major importance. Two are in the Soviet Union, one in Roumania.

Grozny is located on the north flank of the Ural Mountains, not far from the Caspian Sea. It has yielded 1.8 per cent of the aggregate and now accounts for one per cent of the annual world production. A peak of more than double the present annual was reached in 1932, and no new fields have been discovered in recent years. Consequently, the area probably will decline in relative importance.

Maikop, on the north slope of the Caucasus but nearer the Black Sea than Grozny, has yielded 0.2 per cent of the aggregate and now accounts for 0.8 per cent of the annual world production. This area has greatly increased production during recent years and offers promise of continuing to do so. Hence, it is likely to maintain or slightly increase its relative standing.

Aggregate production in Roumania amounts to 4.1 per cent, and annual production to 2.5 per cent of the world total. All fields are in the foothills belt of the Carpathian Mountains. The principal group are in the vicinity of Ploesti, northwest of Bucharest, but some minor ones are farther north. Production reached a peak in 1936 and has since declined by nearly 25 per cent. Moreover, as prospecting proceeds outward into the plains, away from the oldest fields, structures become increasingly difficult to locate and less apt to be productive. Roumania seems destined gradually to decline in importance.

Minor Areas:—Four European areas may be regarded as having noteworthy yet minor importance in the world picture.

Northwest Germany, near Hanover and Hamburg, in certain respects is the most interesting. Although cumulative production amounts scarcely to more than 0.1 per cent of the world total, half has been produced during the period 1931–38, and 14 new fields have been discovered since 1934. Current production amounts to 0.2 per cent of the world, but may be expected to increase. Furthermore, the entire northern plains of Germany constitute an attractive area for future prospecting. Geological conditions, however, will make progress slow and costly.

The Polish fields, in the Carpathian foothills belt of Galacia, account for nearly 0.8 per cent of the world aggregate production. Their peak, however, was reached in 1909, so their annual production amounts to only 0.2 per cent of the world. In recent years new gas but not oil fields have been discovered. Government subsidies now are stimulating prospecting in Galacia and other

regions, so it is possible that the decline may be checked.

Fields along the Emba River, just northeast of the Caspian Sea, account for slightly over 0.1 per cent of the aggregate, and 0.15 per cent of the annual world production. Considerable territory remains unprospected, so the area should maintain or slightly better its position.

The western foothills of the Ural Mountains and outlying plains constitute an area whose future cannot yet be evaluated. Since 1929, oil has been discovered at several widely scattered localities, but none has yielded a really commercially important field. The entire area is represented by one symbol on Figure 1.

No other European area may be regarded as having more than trivial importance.

Hydrogenation of Coal:—To complete the picture of Europe's oil resources it is necessary to mention synthetic oil produced almost entirely by hydrogenation of coal. The process remains costly in spite of much recent research. Several European countries, nevertheless, are developing the industry in order partially to offset inadequate or non-existent domestic crude reserves.

IRON ORE

Preliminary Statement:—Europe possesses nearly two-fifths the known available iron-ore resources of the world. Current consumption, on the other hand, is three-fifths of the world output, and production only slightly less.

A mere comparison of published figures for world iron-ore reserves gives no true picture of the relative importance of different areas. The grade, character, and accessibility of the ore as well as many other technical aspects must also be considered. This necessarily involves personal judgment. In this paper, evaluation is based on reserves of exploitable or marginal ore, thereby leaving out of the picture iron ores that are much too inaccessible, too low grade, or too high in certain impurities to be exploited under present conditions.

Outstanding Districts:—Areas whose exploitable reserves have a metallic iron content exceeding 750 million tons are here classed as outstanding. There are at least five in the world, two in Europe.

FIGURE 5.—View from main pit, across town of Kiruna, with Luossavaara pit in background; northern Sweden.

Kiruna, in northern Sweden (Figure 5), has one huge ore-body, which even above 1500 meters depth contains 1.5 billion tons of ore averaging considerably better than 50 per cent iron, as well as several small ore-bodies. The Lorraine, or "Minette" province (Figure 6), extends from Nancy northward to beyond the Luxemburg border. Reserves amounting to several billion tons of ore, better than 25 per cent in iron, lie almost wholly in eastern France.

Major Districts:—Districts classed as "major" possess readily exploitable ore whose metallic iron content ranges from 200 to 500 million tons. Furthermore, they are or could be worked by large scale mines.

FIGURE 6.—Open cut in "Minnette" ore, in France, near north end of Longuy basin, only 150 feet from Luxemburg border.

Malmberget, near Gellivare, and not far southeast of Kiruna, possesses a group of large and small ore-bodies whose aggregate reserves to no greater depth than 500 meters amount to 400 million tons containing considerably better than 50 per cent iron. Present production is small compared to resources.

The Cleveland Hills and Northamptonshire area of northeastern England possesses huge reserves. Seams are thickest and best, however, close to their outcrops in localities now being exploited and grade downward into submarginal ores. Reserves of exploitable and marginal ores, therefore, certainly must be less than a billion tons, representing an iron content of not more than 350 million tons.

Kirvoy Rog, in the Ukraine, is the most difficult to evaluate. Different estimates place the reserves at from 100 to 1,000 million tons of high grade ore, averaging better than 50 per cent iron. At the 1937 International Geologic Congress no facilities were available for reliable estimates, but the author's general impression would put the figure at several hundred million tons. In addition, there are really huge reserves of low grade ore whose silica content increases as the iron decreases.

Minor Districts:—The "minor" districts, in general, have reserves containing from 50 to 150 million tons of metallic iron and are not capable of being worked by large-scale operations. They can serve as contributing but not major feeders to iron and steel centers.

Figure 1 shows symbols for two minor districts in the Ural Mountains. One is Magnitogorsk (Figure 7), the other represents a group whose largest is at Nizhny Tagil (Figures 8 and 9). The Soviet Union also possesses reserves of unknown size and tenor in the Kertch Peninsula, but as they are not being appreciably exploited, their potential commercial value must be trivial.

Scattered mines and districts occur throughout the entire northern half of Norway. Even the largest, Sydvaranger, in the extreme northeast, alone would scarcely rate as a minor district, yet in aggregate the area possesses several hundred million tons of exploitable ore.

In central Sweden are Grängesberg and several districts of trivial importance. Reserves at Grängesberg, estimated only to a depth of 500 meters, amount to 120 million tons of ore carrying better than 50 per cent iron.

The richest ores now being exploited in Germany are in Siegerland, whose known reserves, however, do not exceed 50 million tons. These ores are particularly valuable because of their manganese content. Much larger reserves of lower grade ore lie in two districts, Lahn and Dill to the southeast. All three are included under one symbol in Figure 1. North of the Harz Mountains, near Brunswick, are rather large reserves of ore that normally would be considered submarginal; under the controlled economy now existing, nevertheless, the district is Germany's largest producer. Similar abnormal production is being obtained from Bavarian and other districts.

The most noteworthy district acquired through Germany's recent expansion is Eisenerz, in Styria. Exploitable reserves probably are in the neighborhood of two hundred million tons containing more than 35 per cent iron. In Bohemia, southwest of Prague, are sedimentary deposits which in 1937 yielded 1½ million tons of ore. Production could not long be maintained at such a rate, however, on reserves recently estimated by the U. S. Bureau of Mines (Foreign Minerals Quarterly, Vol. 1, No. 1, p. 40, 1938) at 25 million tons of exploitable plus larger submarginal ore. Reserves of Moravia rank as trivial.

Yugoslavia is the only other central European country having more than trivial reserves. The deposits, represented by a single symbol, occur northwest of Sarajevo and south of Prijedor, both in Bosnia. Reserves have been estimated at 200 million tons of ore, but half of this may prove too low grade for exploitation.

Although England is credited with enormous reserves, Cumberland is the only district other than Cleveland now having commercial significance. The future of Cumberland depends on the rate at which new ore-bodies are discovered, but the peak of production is definitely passed.

In northwest France are scattered sedimentary deposits whose aggregate reserves may be very large. Since the proportion of exploitable to sub-marginal ore is uncertain, however, and since no single locality is capable of really large-scale production, the area is included among minor rather than major districts.

The resources of Spain are difficult to evaluate. Bilbao and its satellite, Santander, on the basis of past production, would rank as a major district. Reserves are more than three-fourths depleted, however, and now amount to not much more than 50 million tons of ore. Ranking next in immediate importance are scattered deposits in three provinces along the south coast, represented in aggregate by one symbol on Figure 1. Their aggregate workable reserves must be well over 100 million tons. Other deposits, perhaps in aggregate larger than those of the south coast, but whose commercial value is very uncertain, lie in three provinces near Oviedo. There also are scattered trivial deposits at numerous other localities.

FIGURE 7.—Large apartment at Magnitogorsk, largest iron-ore producer and steel center of the Ural Mountains.

COPPER, LEAD, AND ZINC

Copper:—Although Europe consumes more than half the world's copper, it produces only about a tenth and is even more strikingly deficient in reserves. Precise figures for resources are impossible, but it is safe to say that Europe possesses no more than three per cent. Consequently, there are no outstanding districts.

Major districts in their probable order of current production are: Bor in Jugoslavia (Figure 10), Rio Tinto in Spain, Mansfeld in Germany, and Krasno-Uralsk in the Soviet Union. Each now produces between 1.5 per cent and 2.5 per cent of the world total. Bor has the smallest assured reserves, yet offers the greatest hope for increased production. Rio Tinto's large reserves

are mostly low grade, and so are not likely to yield production greater than prior to the Spanish civil war. Reserves at Mansfeld also are large but too low grade to be worked without subsidy. Krasno-Uralsk is the largest of several copper centers in the eastern Ural Mountains. None of the mines seems to have either large reserves or high-grade ore, but their aggregate output is important to the Soviet Union. The real value of these deposits must remain uncertain until more information is released by the Soviet government, but it is not impossible that they may soon be depleted, at least of ore that can be worked without a subsidy.

Figure 1 shows symbols for three minor districts. The one in Norway represents an aggregate of twenty-odd trivial districts scattered close to the Swedish border. The other two are Outokumpu and Boliden in Finland and Sweden, respectively. Ore from Boliden, it may be noted, is more valuable for gold than copper.

Lead and Zinc:—Lead and zinc generally found associated are best considered jointly. In Europe, these metals are more abundantly distributed than copper, yet are inadequate for demands. Europe consumes about three-fifths the lead and more than half the zinc but produces only about a fifth of the lead and a quarter of the zinc output of the world.

Outstanding districts are:

District	*Location*
Silesia	Poland and Germany
Trepča	Jugoslavia

Each now yields more than 4 per cent of the world aggregate and possesses reserves capable of maintaining production on the present scale for more than 25 years. Silesia, which produces

FIGURE 8.—Main pit of Vysokaya mine, at Nizhny Tagil, second largest producer of iron-ore in the Ural Mountains.

FIGURE 9.—Street scene at Nizhny Tagil, important iron-ore center in the Ural Mountains.

zinc with only minor lead, is one of the older districts of Europe. Trepča, on the other hand, though in a region of ancient Roman mining, was discovered in 1927. The ore is richer in lead than zinc. Several smaller ore-bodies have since been discovered in the region, and much of central Serbia is being actively prospected.

Two major districts—Iglesias, on the island of Sardinia, and Larium, in Greece—now produce between one and two per cent of the world total. Zinc predominates at the former, lead at the latter locality. Each will probably be able to maintain its present output for some years, though possibilities for Iglesias seem somewhat brighter than for Larium.

Minor lead and zinc districts are:

District	*Predominant Metal*	*Location*
Reocín	Zinc	Northern Spain
Linares	Lead	Southern Central Spain
Cartegena	Lead	Southern Spain
Klagenfuss	Lead	Austria-Jugoslavia
Bad Grund	Lead	Harz Mtns., Germany
Bad Ems and others	Lead	Rhine Valley, Germany
Derbyshire and others	Lead	Northern England

Each now produces less than 1 per cent of the world aggregate. The first three doubtless will greatly increase production, now that the Spanish civil war has ended, so perhaps should be included in the "major" group. The last four, on the other hand, are operating on more of a marginal basis and, barring unexpected discoveries, should remain "minor." The mines of northern England, whose production fell by 50 per cent in three years, may soon be depleted.

LESSER METALS

Aluminum:—Districts producing more than trivial quantities of aluminum, tin, and ferro-alloy ores fall conveniently into two rather than three categories of importance, since world output is much less for them than for the minerals previously discussed.

Outstanding bauxite districts are Brignoles and Gánt (Figure 11), respectively, in southern France and northwest Hungary. They are the two leading producers of the entire world, and each has very large reserves of readily accessible ore.

Subordinate yet important localities include two in southwestern France and a group extending along the Adriatic coast from Italy to Greece, the most important being shown on Figure 1. Still another locality, southeast of Leningrad, accounts for nearly all the Soviet production; the size and value of these deposits are veiled by censorship, but they probably are inferior to those in Jugoslavia.

FIGURE 10.—Street scene at Zaječar, rail center, 30 km. from Bor copper mine.

Tin:—The classic mines of Cornwall, England, now produce less than one per cent of the world's tin ore. Elsewhere, Europe is virtually devoid of tin resources.

Manganese:—Nikopol, in the Ukraine, and Tchiatouri, south of the Caucasus Mountains, together produce more than half the world's manganese ore. Probably the former is now the larger producer, for the richest ores at Tchiatouri are reported to have been exhausted.

FIGURE 11.—Haulage incline from bauxite pit of Gánt, Hungary.

Each seems to have adequate reserves, however, to maintain current production for many years. Increases from the Union of South Africa, Brazil, and Cuba are likely to diminish somewhat the relative standing of the Soviet Union.

Scattered small and marginal deposits occur in Hungary, Roumania, Italy, and other countries. They now contribute scarcely more than trivial amounts of ore, but could in a crisis be drawn upon more heavily for periods of a few years.

Chromium:—Remarkable increase during recent years has placed the Soviet Union first in world chromite production. All their deposits are in the Ural Mountains. By far the most important district is Saranovskoye, whose reserves are sufficient to maintain current output for many years.

Of much less importance are the small chromite deposits northwest of Skoplje, in southern Serbia. These cannot hope to become more than small contributors to world demand.

Nickel:—All but an insignificant amount of nickel ore is produced in Canada. The International Nickel Company, however, has recently conducted active prospecting and doubtless soon will produce ore in the Petsamontunturit district of northern Finland. The size of these deposits has not yet been made public, but it is safe to say that they will not in the near future attain the importance of Sudbury.

Scattered deposits near Orsk, in the southeastern Ural Mountains, are being exploited by the Soviet government. They are small and extremely low grade, so could not be worked except by subsidy.

THE PETROLEUM INDUSTRY OF THE GULF COAST SALT DOME AREA

Virginia Bradley

THE Gulf Coast of Texas and Louisiana between Matagorda Bay and Lake Pontchartrain is underlain by a number of subsurface structures known as *salt domes*. Within that area more than 160 salt domes had been discovered by 1937, most of them oil bearing structures (Figure 1). Since the first "gusher" was completed in 1901, the region, as well as the first field, Spindletop, has been in continuous production, furnishing records over a long period of time and making possible a comparison of early and modern methods of development.

The coastal location of the salt dome area is an important factor in the exploitation of its petroleum reserves. Since the Gulf Coast with its sparsely populated hinterland does not provide a large market for petroleum products, surpluses of crude and refined oils must be shipped to areas where there is a greater demand. The low cost of water transportation compensates in some measure for the region's isolation from major consuming centers of the United States (Figure 2).

At the turn of the century the industrial east was the most important domestic market for petroleum. In 1900, there were only 67 refineries in operation in the United States; of these 47 were in the four states of New York, New Jersey, Pennsylvania, and Maryland, while there was only one in Texas and none in Louisiana. Now that gasoline is the product most sought by the refiners, the gasoline consumption of a state may be taken as an index of its importance as a market. The state of New York alone uses 116,700 barrels of gasoline per day, and other populous states of the North Atlantic Coast likewise are heavy consumers. Since the production of the Appalachian fields is inadequate to supply this demand, the Gulf Province is favorably located to ship large quantities of crude to the eastern refineries or of gasoline to the consuming centers they serve.

Although their demand is small in comparison with that of the Northeast, the southeastern states may also be easily reached by water. The other consuming areas of the United States—the Middle West, the Rocky Mountains, and the Pacific Coast—are supplied with petroleum from fields more advantageously located with respect to their markets. Foreign markets for the products of the Gulf Coast region are reached through the two great ports, New Orleans and Houston, and through a number of smaller ones.

Cultural Features

Although predominantly native white, the population of the Gulf Coast includes many negroes. The population density is low because large tracts of marsh and pine forest support few people. Agricultural activities range in character from sugar plantations to subsistence farms, and from extensive pastures on which Brahma cattle graze to smaller tracts devoted to vegetables or fruits. Rice, cotton, early vegetables, and fruits are grown in coastal Texas and Louisiana, and near the cities dairy products, poultry, and eggs are important sources of income.

When oil was discovered in 1901, the region already possessed several cities of moderate size. New Orleans was an important port with good railroad and steamship connections. Beaumont was a thriving lumber town, Galveston a well established port, and Houston a railroad center. An adequate system of railroads had developed in conjunction with these cities. In recent years the facilities for water shipment on the Gulf Coast have been greatly improved. The Intracoastal Canal, running through the heart of the oil region, carries large quantities of crude oil to the refineries in the vicinity of the Gulf ports. These ports have ship channels 26 to 35 feet deep and berthing space for more than 70 tankers.

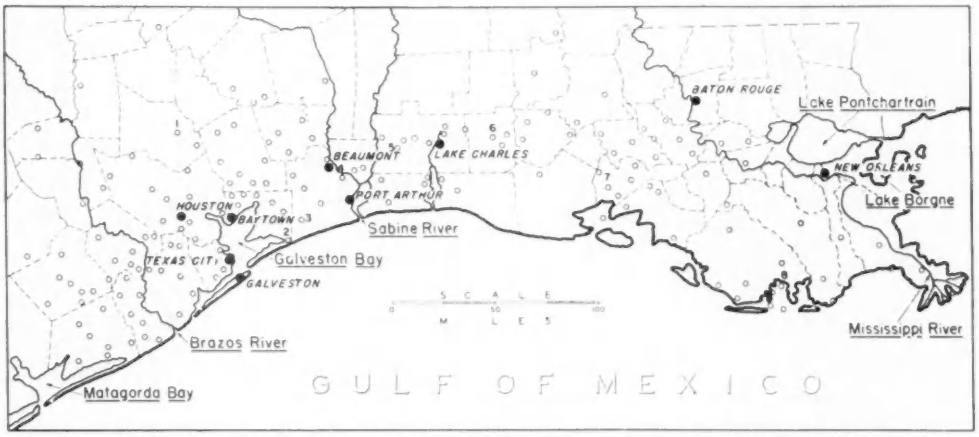

FIGURE 1.—Salt dome area of Texas and Louisiana. Cities shown with solid dots and salt domes with open circles. (1) Conroe, (2) High Island, (3) Big Hill, (4) Spindletop, (5) Vinton, (6) Welch, (7) Avery Island, (8) Lake Barre.

CLIMATE AND VEGETATION

The Gulf Coast area has a humid subtropical climate, with winter temperatures that seldom drop below freezing. The annual rainfall which is well distributed throughout the year varies from 45 to 55 inches, the maximum coming in summer. Relative humidity is high, averaging 80 per cent. As a result of the open winters, outdoor work continues uninterrupted through the year, and the ample rainfall gives rise to many streams which furnish water to the driller if subsurface supplies are not available.

The flat stretches of the Gulf Coastal Plain are enlivened by diversity of natural vegetation. Belts of forest, prairie, and marsh are aligned approximately parallel to the coast in response to drainage and soil conditions. The poorly drained silts of the tidal marsh border the coast from the east shore of Galveston Bay to Lake Borgne, this broad strip of land being covered by reeds and rushes. At the inner margin of the marsh in southeastern Louisiana there is an area of swamp where the often flooded lowlands are clothed with cypress, tupelo, gum, and magnolia. In east Texas and southwest Louisiana, the coastal prairie lies at the inner margin of the tidal marsh. Farther inland lies the pine forest. On the uplands, almost pure stands of pine form an open woodland, but dense thickets of hardwood are found on the stream bottoms. West of the Brazos River, live oak and post oak replace the pine and extend to the coast.

TOPOGRAPHY

The surface of the Coastal Plain rises imperceptibly from sea-level to about 500 feet at its inner margin. Its broad, monotonous expanses may be divided into three belts parallel to the coast. The coastal marshes and swamps form a vast tract of poorly drained land extending from the east shore of Galveston Bay to Lake Pontchartrain. Through the lower Mississippi delta, meander numerous bayous intersecting the large shallow lakes to form a network of drainage channels. The coastal marsh, lying at an elevation of only three or four feet above sea-level, is frequently inundated when a strong south wind drives the water inland. The rivers of the coastal marsh are sluggish like those of the lower delta, but they exhibit a strong tendency to spread out into a chain of wide shallow lakes in their lower courses, entering the Gulf through bays or estuaries. Above the flat expanses of these poorly drained lands rise occasional ridges and mounds, the ridges being the natural levees of the streams or the sandy deposits built up by the waves at a time when the shore stood at a different level, while the mounds are usually associated with salt dome structures.

The next belt, known as the coastal prairie, has a flat, monotonous surface extending for miles without any perceptible break. The seaward margin of the prairie is formed by the marsh as far west as Galveston Bay. At that point begins a succession of lagoons and estuaries sheltered from the Gulf by a series of long sandy spits and barriers behind which lie the important Texas ports. East Texas and the adjacent part of Louisiana are abundantly supplied with water courses, but in spite of this fact, the prairies are poorly drained. The large through-flowing streams have entrenched themselves below the general level of the surface, leaving terraces above their present floodplains. The smaller consequent

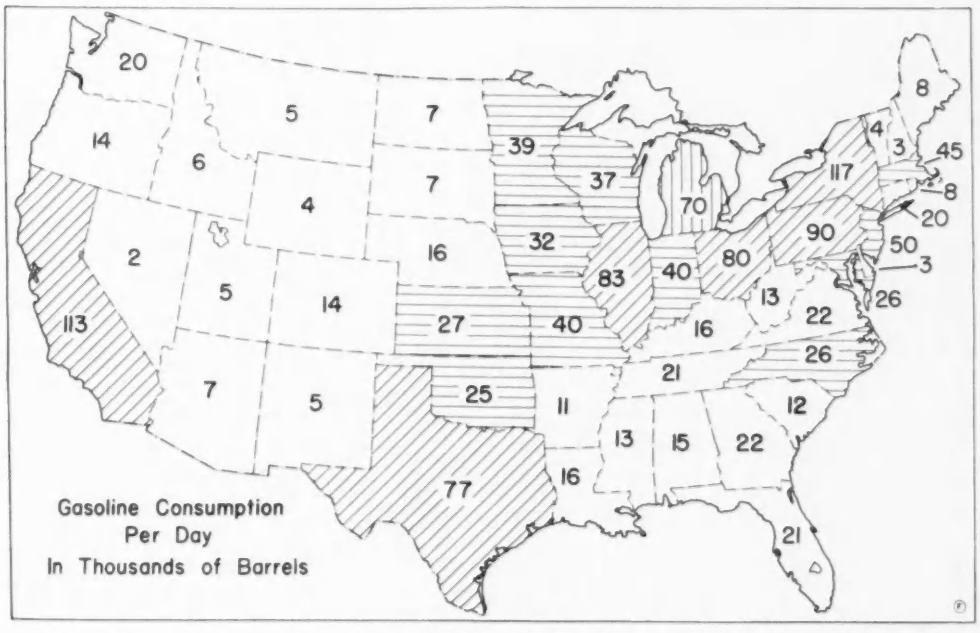

FIGURE 2.—Daily consumption of gasoline by states. (Data from the *Oil and Gas Journal.*)

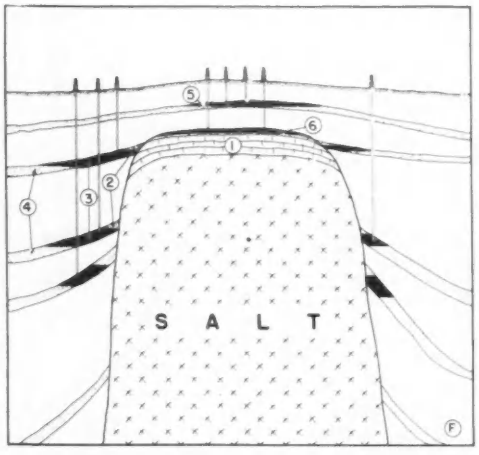

FIGURE 3.—Cross section of an idealized salt dome showing the core of crystalline salt, the cap rock (1), and the tilted sedimentary rocks through which the salt mass has been thrust. Oil (3) may be found associated with gas (2) and salt water (4) in the flank sands, in gently arched sands above the salt core (5), or in the cap rock (6). Though all three occurrences are shown on this structure, a salt dome usually produces from only one or two of these possible traps.

streams flow in shallow grooves. Rising conspicuously from the level prairie are two classes of hills or mounds. The "pimple" mounds, extending from Welsh, Louisiana, across the Sabine River into Texas, are twenty to sixty feet in diameter and two to ten feet high. Though their origin was unexplained, careful observers soon realized that they had no structural significance. The mounds associated with the salt domes vary in size, being from 5 to 83 feet high and from 100 to more than 2,000 acres in extent.

The belt of land on the inner margin of the prairies is better drained and more dissected. It is characteristically rolling and may have as much as a hundred feet of relief between the crest of the hills and the troughs of the valleys. Here the mounds associated with salt domes, if present, are either inconspicuous among the other hills or have been altered by erosion.

GEOLOGY

The sedimentary rocks which underlie the Gulf Coast have many features in common. The beds, which are predominantly unconsolidated sands and clays, dip gently seaward. Being nearshore deposits they are extremely discontinuous and subject to pinching out within short distances, the lenses of sand and clay overlapping and merging into one another in a confusing manner. They are difficult to identify and correlate because, except for microscopic species, fossils are scarce. Within this area of gently tilted young sediments, the structural conditions necessary for the trapping of oil are provided by the salt domes. A salt dome (Figure 3) consists essentially of a core of crystalline salt which has penetrated the overlying sediments. The strata in the immediate vicinity of the intrusive mass are uplifted and fractured. The salt mass itself is circular or elliptical in plan, with nearly vertical sides. The top is flat or dips at a low angle. In addition to the essential salt core, there are other rocks and minerals often associated with salt domes that are not usually found elsewhere in this region. The cap rock, if present, may be composed of crystalline limestone, anhydrite, gypsum, and sulphur, while the occurrence of oil, gas, and salt water is not confined to any single portion of

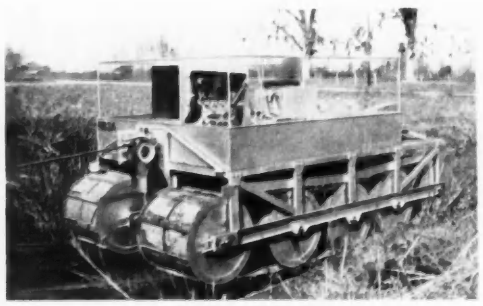

FIGURE 4.—A marsh buggy designed for use in the coastal marshes.

the structure. Depending on the distance the core has penetrated the overlying strata, the salt mass may be present within 15 feet of the surface, as at Avery Island, or buried under thousands of feet of sediments, as at Lake Barre where salt was reached at 11,300 feet.

EXPLORATION

In the petroleum industry, exploration has unique importance. Because of the localized and obscure occurrence of petroleum deposits and the great demand for the products, overproduction and lack of sufficient reserves can exist at the same time. In the Gulf Coast Province, exploration has passed through two periods, the first ending with the successful use of geophysics in 1924.

When prospectors came to the Gulf Coast they found a region unlike Pennsylvania or California. No well developed folds were visible at the surface to give clues to the underlying structure. There were only flat expanses of prairie, marsh, and forest extending in all directions, broken occasionally by mounds which rose above them. During the first period of exploration, the search for petroleum was characterized by two phases, namely, dependence on surface indications and random drilling. Without any specialized knowledge, the prospectors realized that oil and gas seeps indicated the presence of oil, but until the association of oil deposits with salt domes was proved by the first gusher at Spindletop, the search for petroleum on the Gulf Coast was unsuccessful. Once this essential relationship was understood, however, the mounds and the minerals characteristic of salt domes acquired a special significance. Mounds, being the most noticeable surface expression of salt domes, were the first feature to attract the attention of oil operators. Because of their apparent similarity to Spindletop, High Island, Big Hill, and about twenty other mounds were drilled during this period. Although they had no structural significance, the "pimple" mounds were the sites of many dry holes because of their resemblance to salt dome mounds.

Meanwhile, the less conspicuous indications of oil were not being overlooked. Oil seeps were of limited occurrence and therefore did not figure in many discoveries. Gas seeps, on the other hand, constituted the most numerous clues to the presence of oil, being found in all except one of the fields discovered prior to 1918. Paraffin dirt is a yellow substance having a "curdy" or "rubbery" texture. Though its chemical composition was much discussed, the only point generally agreed upon was that it contained no paraffin. Since it is found only in the vicinity of gas seeps, its value as an indication of oil is about the same as that of a gas seep. Sulphur water, often called "sour water," and salt springs were of minor importance.

The most obvious structures were, of course, located first. Then followed a long period during which discoveries were infrequent, because many of the salt domes gave no surface indication of their presence and no method had been devised to reveal what lay below the surface. During this period, the Gulf Coast was known as a "wildcatter's paradise," and the ratio of dry holes to producing wells was higher than in most regions. Even if a salt dome were discovered, there was no certainty of finding oil on it, or if oil were present, of locating the deposit at the first attempt. Since oil may collect in one of several different places on a salt dome, a structure was sometimes discovered years before it produced oil. High

Island, for example, was known before 1901, and was drilled intermittently from 1901 until oil was struck in 1922. In spite of the crude methods employed, forty-six salt domes were discovered between 1900 and 1924; of these thirty-nine produced oil. (The number of fields discovered in a given period will vary according to whether the date of discovery is based on the finding of the dome or the actual production of oil. The two dates may vary widely, as in the case of High Island, or they may coincide.)

FIGURE 5.—The marsh buggy in action, carrying a geophysical crew.

The second period was initiated by the success of geophysical instruments, which were introduced experimentally in 1922 and proved practicable by 1924. The Gulf Coast is peculiarly suited for this form of prospecting, as unconsolidated sediments extend to great depths and the density of the salt masses differs sharply from that of the surrounding rocks. Several types of geophysical instruments have been used, some being more successful than others. The magnetometer was the cheapest and most rapid to operate, but was not very popular. By 1927 only two remained in use on the Gulf Coast. The pendulum and the torsion balance respond to gravity variations. The pendulum was never widely used, but the torsion balance became the foremost reconnaissance instrument. The seismograph is adapted to the detailed mapping of a small area. Usually two or more instruments are used on one prospect. It is common practice to employ a magnetometer, pendulum, or torsion balance for reconnaissance work, then to make the exact location with seismograph. The comparative popularity of the torsion balance is indicated by the fact that in 1927, twenty-five torsion balances were in use in contrast to one pendulum outfit and two magnetometers. A recently developed reconnaissance instrument is the gravimeter, so improved that it is now three to ten times as fast as the torsion balance. Inasmuch as it is not affected by rolling topography or forests, it is being used on the inner margin of the Coastal Plain. Another new technique, too expensive for reconnaissance work, is the drilling of holes to a depth of 1,000 feet. When these holes are electrically surveyed the resulting logs give a good indication of the underlying structure. An examination of the well logs of the proved fields shows that nearly all of them have some structural expression at a depth of 1,000 feet.

Technical difficulties were not the only problems which beset the geophysicist during this period of rapid expansion. The field of exploration was broadened to include large expanses of coastal marsh and even open water. In such areas the usual caravan of cars and light trucks with their built in equipment obviously could not be used. Transportation on the marsh is accomplished with the aid of an ingenious contrivance known as the "marsh buggy" (Figures 4 and 5). The frame of a car or light truck is mounted on wheels widened by means of wooden boards, metal cylinders, or large tires to prevent their sinking into the soft mud. In the dense tangle of the cypress swamp, the crew have to

carry their equipment and cut a trail as they go. Often they use a tree stump as a solid support on which to set up their instruments. When a large water body is to be explored, boats must be used (Figures 6 and 7). The Salt Dome Oil Company, operating in Galveston Bay, used a fleet of nineteen crafts, including a two-story houseboat on which the crew lived during the week.

It is obvious that exploration on such an elaborate scale must be expensive, but the cost is amply justified. From 1924 to 1937 more than 118 salt domes were located, ninety-seven of which are proved oil fields (Figure 8). This is more than twice as many structures as were found during the whole twenty-four years of the first period.

PRODUCTION

Unlike the exploratory phase of the industry, drilling methods have undergone no revolutionary changes. Although standard tools were being used in nearly every oil field in the country in 1901, the rotary system has been used on the Gulf Coast from the first. The rotating bit cuts the soft formations easily and their finely ground fragments are carried to the surface by the constantly flowing stream of drilling fluid. There is little danger of a cave-in occurring, for the weight of the circulating mud exerts a considerable pressure on the sediments. The abundance of local timber during the early period of exploitation led to the construction of wooden derricks. The rotary rig was quite small at this period, and the drilling fluid was mixed of natural clays and replenished from the drill cuttings and water bearing horizons as the hole was deepened. Irrigation canals of the surrounding rice fields often supplied the water for drilling.

With crude methods and machinery, drilling did not always proceed smoothly. That the rotary drill was not then adapted to hard rock is shown by the record of one well which took seventy-five days to penetrate twenty-seven feet of siliceous limestone. At Vinton, a bed of heavy gravel caused several wells to be abandoned because the rig could not lift the large quartz pebbles. However, the most frequent and troublesome problem that the driller had to meet was a blow-out caused by heavy gas pressures. Sometimes the eruption was not destructive, but in other instances the drill pipe was blown out of the hole, and in extreme cases a crater was formed, endangering other wells in the vicinity. Fires also resulted from the inflammable gas which often carried sand in suspension, forming a natural sand blast. Salt water, sometimes produced with the oil, created a problem of a different nature. Since surface streams were used in many places to irrigate rice, the salt water could not be released into them, but had to be stored to avoid pollution.

FIGURE 6.—Motor boat used for transportation of geophysical explorers in southern Louisiana. Notice the two marsh buggies in the background and the characteristic vegetation.

Drilling techniques were little developed at this period. The main principle, subscribed to alike by producer and land owner, was to obtain as much oil as possible in the shortest time. Far from conserving the gas pressure, op-

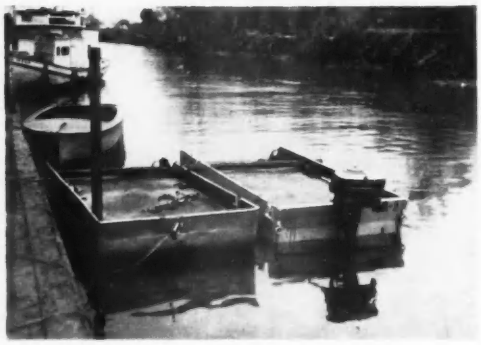

FIGURE 7.—Small barge used for drilling shot holes on water locations. The two sections of the barge may be put together end to end, or, if a hole is to be drilled, the two sections are placed side by side and held together by the pipe across the front. The drill goes in the slot between the two.

erators often allowed gas wells and even oil gushers to run wild. The Lucas discovery well (Figure 9), for example, ran nine days before being capped. The value of proper well spacing was unknown, and the scarcity of reliable well logs indicates that the drillers followed the example of their employers in putting speed ahead of all other considerations. All early salt dome fields were shallow, reaching depths of 850 to 2,000 feet, but by 1907 wildcats had penetrated to depths exceeding 3,000 feet.

The modern rig is a formidable affair compared with the one that drilled the Lucas well. The old wooden derrick has been replaced by a steel structure (Figure 10), and, because of the frequency with which rotary bits must be sharpened, the derrick is made as tall as possible to accommodate long sections of drill pipe. The more common height is 122 feet though some wells have 136 foot derricks. Many improvements have been made in drill pipe and bits. The drilling fluid is usually a natural mud mixed from local clays, but because the weight of a column of mud at depths greater than 6,500 feet is often sufficient to seal the oil or gas in the formation, special chemicals may be added to reduce its weight.

Stimulated by geophysical discoveries and supplied with excellent tools, drilling steadily penetrated to greater depths. In 1929, 5,000 foot wells became common, in 1935, the first test below 10,000 feet was drilled, and at the end of 1938, twelve fields were producing below 10,000 feet, one of these, then the deepest producer in the world, finding oil at 13,266 feet.

Even though great advances have been made, the driller is still vexed by a number of problems. "Heaving shale" sloughs into the hole and blocks progress. Blow-outs and craters still occur in spite of devices known as blow-out preventers, and crooked holes are caused by the drill stem bearing too hard against one side of the hole. With an increasing number of fields, the disposal of salt water which is produced with the oil has become a pressing problem. It cannot be released into the streams because pollution would injure fresh water fish and render the streams unfit for irrigation. Wells located in the marsh or bay endanger valuable shrimp, crab, and oyster fisheries; therefore the polluted brines from the oil wells cannot even be released into the salt water of the Gulf. One method of disposing of the brine is to store it in earthen reservoirs until winter, when the rains dilute it and irrigation is not practiced. When there is too much salt water, or when the well is located in the marsh or bay, this method becomes impracticable. The Texas Company, operating its Lake Barre field, was the first to solve the problem by pumping the brine back into the ground through a well especially drilled for that purpose. In August, 1937, there were eight fields in South Louisiana using this method of waste disposal.

On the other hand many improve-

ments have been made in the techniques for obtaining information about the formations through which the hole is passing. This information is vital if the driller is to know when to expect a troublesome gas zone or even the oil sand. It is also important in the location and drilling of other wells in the same field. Coring was one of the earliest means of answering this need because it simply brought up a section of the rock so that it could be examined, but coring is much more extensively practiced now than it was in the early Gulf Coast fields. Though samples taken from the drill cuttings were examined from the first, they have acquired a new significance since the introduction of a technique of identifying certain horizons by the microscopic fossils they contain. Because of their small size these fossils are not broken by the bit. Another valuable instrument is the electrical coring device which is used after the completion of the hole to reveal any oil sand which may have been sealed off by the pressure of the mud.

When geophysics led the search for oil into the marshes and lagoons of the coast, the difficulty of constructing proper foundations for heavy drilling machinery required prompt solution. Where a marsh location was to be developed, matting proved to be most economical. A floor of planks was laid on the surface of the ground and surmounted by a structure of steel or timber on which the derrick was built. The first wells in open water were drilled on pile foundations, but these proved to be costly. Drilling barges were the next improvement, floating barges being used in quiet waters. The submersible barge is adapted to less sheltered locations. It is constructed of steel and measures about sixty-six feet long by twenty-eight feet wide. Because it draws only eighteen inches of water it can be used in most of the shallow lakes and bayous. Frequently canals are dug to a marsh location in order that barges may be used. When a barge has been floated into position, the seacocks are opened and it is allowed to fill with water and sink. After the well is completed, the water is pumped out and the barge rises to the surface again. These barges effect a tremendous saving in time and labor because there is no necessity for tearing down and rebuilding the derrick and rig whenever they must be moved to a new location.

During the second period, operators as well as geologists came to realize that an oil field is a natural unit, and, therefore, can be most efficiently developed as such. This includes proper

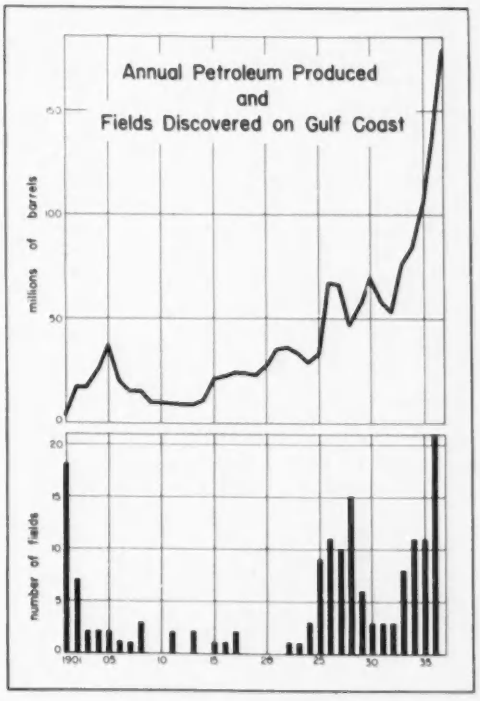

FIGURE 8.—Annual production of the Gulf Coast (statistics from the *Mineral Resources of the United States* and the *Minerals Yearbook*) and number of fields discovered each year (data from *Gulf Coast Oil Fields* published by the American Association of Petroleum Geologists and the *Oil and Gas Journal*).

spacing of wells and conservation of the gas pressure. Spacing is important because if too many wells are drilled, they cause the edge water to invade the field in an irregular fashion, quite aside from the fact that fewer holes could have produced the oil much more economically. Recently drilled fields have used the unit of one well to twenty acres. Maintenance of gas pressure in the Gulf fields usually takes the form of controlling the whole producing formation and returning the gas to the field through several key wells. Such repressuring not only saves the expense of pumping, but increases the ultimate amount of oil that may be recovered.

Since time is a major factor in the expense of developing an oil field, far-sighted operators have learned to plan ahead when a new field is to be opened. After the drilling locations have been determined, a system of permanent roads is laid out so that all sites may be easily reached. In some fields the fuel and water systems are laid parallel to the roads, and often several locations are prepared in advance so that the drilling rig can be moved in without delay. The advantages of efficient planning were demonstrated by the experience of operators in one field, recently developed, where wells reaching production at 5,500 feet were completed in two to four weeks. Drilling techniques have been improved greatly since Spindletop, when the average time for drilling a hole a little over one thousand feet was two or three months!

TRANSPORTATION AND MARKETING

In the Gulf Coast region, as in the United States at large, pipe lines carry all but a small percentage of the crude petroleum. The pipe lines operate at lower rates than the railroads because of their greater efficiency in handling large volumes of fluid. A typical pipe line system consists of gathering lines, which serve as outlets for the oil from individual wells in the field, and trunk lines, which carry the oil to refineries or terminals. The pumping stations are located at intervals along the trunk lines as well as at the junction of gathering lines and trunk lines. Some of the problems incident to laying and maintaining pipe lines on the Gulf Coast are the clearing of forests, the crossing of the numerous streams and marshy tracts, and the combatting of corrosion. Against the latter danger, the pipes are wrapped and coated with enamel, specially heavy wrappings being used where the line crosses brackish water. To avoid the undue strain which results from frequent heating and cooling, the lines are usually buried thirty-two to thirty-six inches below the surface. Pipe lines on the Gulf Coast form a dense network between Houston, Conroe, and Port Arthur, and link this region with the great Mid-Continent fields.

In coastal Louisiana, water transportation forms the chief outlet for crude petroleum. Most of the pipe lines built in this area are merely connecting links between the field and the deep water terminal. There are two reasons why the companies operating in southern Louisiana have constructed so few pipe lines; one is the difficulty and expense of laying and maintaining a line in the salt marsh, and the other is the availability of water transportation furnished by a network of lakes and bayous. The Intracoastal Canal, which dominates this system, passes through the heart of the oil region from the Mississippi River to the Sabine ports region and Galveston Bay. Although transportation by barge is slower than by pipe line because of the winding courses of the waterways, the cost is about the same.

In spite of the rapid expansion of pipe lines, railroads still handle oil from recently developed fields, and those to which it is not profitable to lay pipe lines. Their chief function, however, is the shipment of refined products.

Large refineries are located at the Gulf ports, where land and water routes meet and storage facilities have been built (Figure 11). These refineries have a strategic location with respect to both markets and oil fields. Tankers, which are even more economical than pipe lines, carry oil from the refineries at tidewater to the eastern seaboard, while crude petroleum moves to the refineries by pipe line from the Gulf Coast and Mid-Continent fields. The majority of the Gulf Coast fields produce heavy oil with an asphalt base and a high sulphur content. It does not bring a high price because it yields a low percentage of the valuable light oils such as gasoline and kerosene, and because the sulphur is corrosive. In the early days most of the Gulf Coast petroleum was sold as fuel oil or lubricating stock, though kerosene was the most profitable product. At present, though fuel oil and lubricants are still important, gasoline is the product most desired by refiners. The invention of cracking has allowed a much greater per cent of gasoline to be produced from a barrel of crude than could be obtained by simple distillation.

The present magnitude of the refining industry is out of proportion to the amount of oil produced in the Gulf Coast alone. Located at the tidewater outlet for the Mid-Continent Province, the refineries draw oil from New Mexico, Oklahoma, Arkansas, and all parts of Texas in addition to that produced on the Gulf Coast. It was estimated in September, 1937, that when the refineries then under construction were completed, the Gulf Coast would have twenty-three per cent of the refining capacity of the United States, or a daily capacity of about 1,000,000 barrels of oil. Because of the absence of shut-down plants, however, this region would have twenty-eight per cent of the total crude run to the stills.

The Gulf Coast is characteristically a region of large and modern refineries which embody the latest technical developments. Several in turn have been the largest refinery in the world.

FIGURE 9.—The discovery well on Spindletop. This gusher, drilled by Captain Lucas, came in January 10, 1901, and initiated the oil industry on the Gulf Coast. The well ran for nine days before it was capped.

The four refining and shipping centers in the salt dome region are the Houston-Texas City area, the Sabine area, Lake Charles, and the Mississippi area, which includes New Orleans and Baton Rouge. Of these four, the Houston-Texas City area and the Sabine area, including Beaumont and Port Arthur, lead the others by a wide margin, each having a refining capacity in excess of 300,000 barrels a day.

SUMMARY

The Gulf Coast petroleum industry, since its establishment in 1901, has experienced an evolution from a simple business depending upon relatively crude tools and methods to a highly complex enterprise. Fields producing from depths of 5,000, 8,000, or 10,000 feet are now being developed in contrast to the early fields which were 1,000 to 3,000 feet deep. Blind wildcatting and dependence on surface indications have been replaced by geophysical prospecting. Well-planned fields with locations on ten or twenty acre plots have to some extent taken the place of the old, haphazardly developed fields in which derricks were sometimes crowded so close together that their timbers interlocked.

The petroleum production of the Gulf Coast has fluctuated within wide limits. Although it has usually contributed only seven or eight per cent of the total production of the United States, this province furnished twenty-seven per cent at the height of its first boom in 1905. In recent years it has been overshadowed by the great volume of oil from the Mid-Continent Province and, to a lesser extent, from California, but it has exceeded the production of all other provinces except these two. The refining capacity of this area exceeds both the production and the

FIGURE 10.—Spindletop oil field today. Note steel derricks.

FIGURE 11.—The Baytown refinery of the Humble Oil and Refining Company on Galveston Bay. Dock facilities are shown in the middle distance where a ship is loading.

demand of the immediate region, for nearly one-fourth of the refining capacity of the United States is concentrated within its borders serving both oil fields and markets outside of the Gulf Coast area.

In the development of the Gulf Coast fields, there were many features which were significant to the petroleum industry. The salt domes attracted wide attention because, although they occur in other countries, they are unique in the United States. More important than the salt domes to operators outside of the area have been the technical advances made in overcoming the difficulties peculiar to this region. While the other oil fields were standardizing on cable tools, the Gulf Coast was pioneering with the rotary system. This drill has made possible the development of unusually deep fields. The Gulf Coast was also the proving ground for geophysical prospecting in the United States, and the use of geophysics in exploring for oil has spread to other regions and been carried into foreign countries.

AGRICULTURAL DEVELOPMENT OF NEW BRUNSWICK

D. F. Putnam

NEW BRUNSWICK is the largest of the three Maritime Provinces of the Dominion of Canada, having a land area of 27,700 square miles or 17,734,400 acres. Of this, 4,151,596 acres, or 23.4 per cent were occupied as farm land in 1930, while only 1,330,232 acres were actually under cultivation. Both occupied land and arable land have suffered a slight decrease from the point of greatest development shown by the census of 1911.

The degree of agricultural development varies greatly in different parts of the province and it is the purpose of the present article to discuss the reasons for this in much the same way as has been previously done for the province of Nova Scotia. The accompanying maps are based upon figures given in Volume VIII of the Census of Canada for 1931. The unit of reference in drawing the isopleths is the civil parish as shown on the map published by the New Brunswick Department of Lands and Mines in 1935.

Physical Background

New Brunswick is a somewhat rectangular area lying approximately between latitude N 45° and N 48° (Figure 1). It has a long coastline, bordering the Bay of Fundy on the south, the Gulf of St. Lawrence on the east, and Baie de Chaleur on the north. There are several large rivers, notably the St. John, Miramichi, Nepisiquit, and Restigouche, which with their tributaries have had considerable influence upon the settlement and development of the province. The chief centers of population are found at the mouths of the rivers or approximately at the head of navigation. Exceptions to this rule of course are the towns found along the St. John valley which itself provided the chief route of travel in the early days.

Physiographically, New Brunswick is related to the folded Appalachian region of New England but the elevations are not so great, Mt. Carleton the highest point in the central highlands reaching 2,700 feet above sea level. Figure 2 is a geological map of the province generalized from the data of the Canadian Geological Survey. It readily illustrates the four physiographic regions into which the province may be divided. Bordering the Bay of Fundy are the Southern Uplands, a region of metamorphosed Pre-Cambrian and older Paleozoic rocks, strongly folded, faulted and eroded, rising in places to about 1,500 feet above sea-level. Approximately one-third of the province is occupied by the great central and eastern lowland developed largely upon the Millstone Grits of the upper Carboniferous system, but with a border of lower Carboniferous limestones. The only important coal mines in the area are found at Minto near the head of Grand Lake. The central highlands are composed of folded Pre-Cambrian and Ordovician strata intruded by a huge granite batholith of Devonian age, much of which has been exposed by subsequent erosion. A large part of this area is rugged country having a general elevation of more than 1,500 feet above sea-level with many peaks over 2,000 feet. Northwestern New Brunswick is a plateau with a general elevation of

about 1,000 feet, developed on calcareous rocks of the Silurian system. This plateau is deeply trenched by the St. John, the Restigouche and their tributaries whose valleys lie from 300 to 600 feet below the general level.

The St. John rises in the state of Maine and for nearly a hundred miles forms the boundary between the United States and Canada. This part of its valley is between 400 and 500 feet above sea-level and fairly broad, with gently sloping sides. In a former geological epoch it was probably drained by way of the Restigouche. At Grand Falls the river plunges into a canyon (Figure

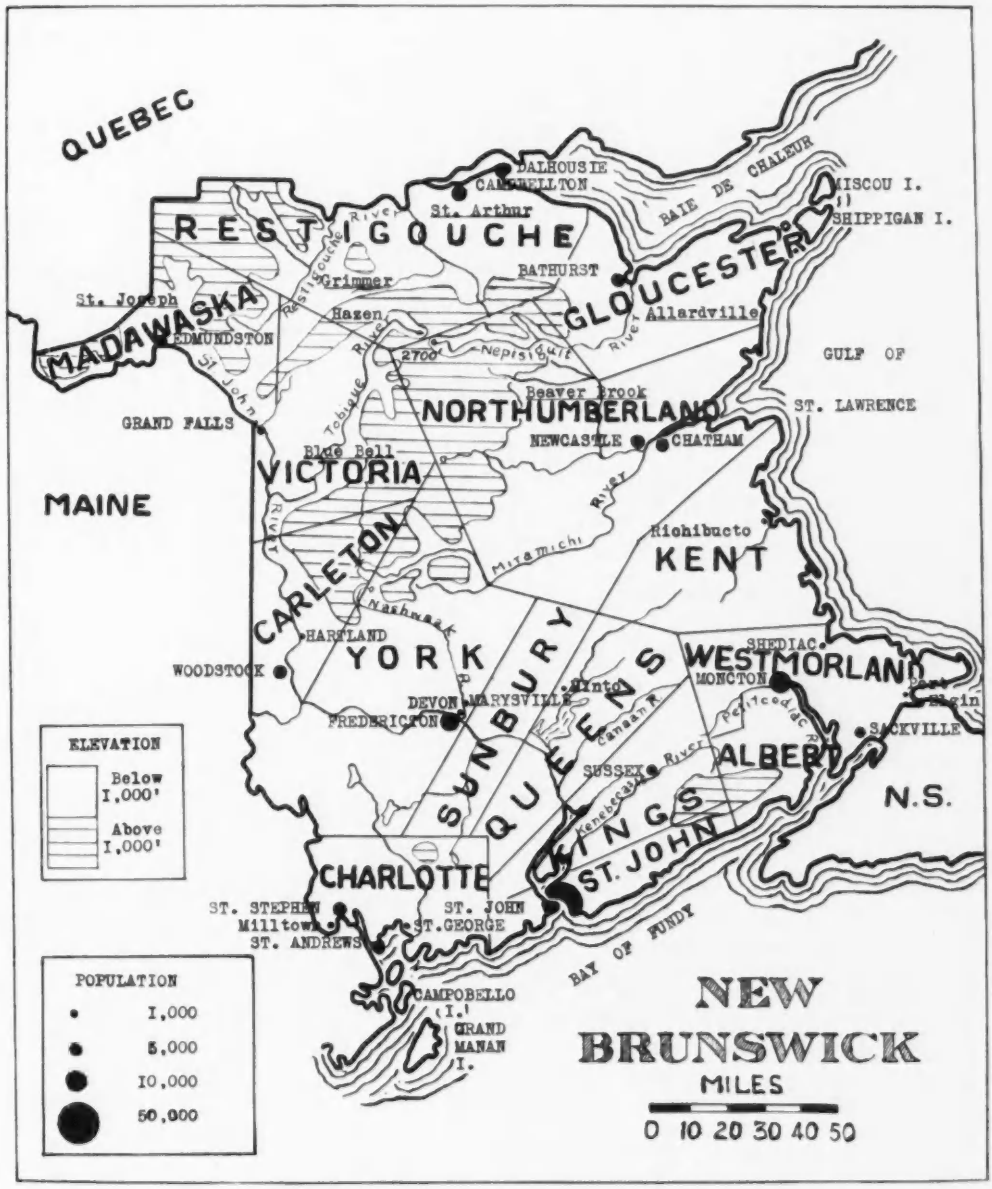

FIGURE 1.—The province of New Brunswick, showing the counties and incorporated cities, towns, and villages. The underlined names in the northern counties indicate the areas of recent colonization.

3) and for the next hundred miles is confined to a narrower and deeper valley. Below Woodstock it turns eastward and crosses the granite batholith to emerge into the central lowlands. Here for many miles the river has practically no grade, being held up by a ledge of rock which forms the famous "Reversing Falls" at the point where the river empties into St. John harbor. At low tide the river rushes seaward over the ledge in a turbulent rapid, but when the tide comes in the harbor fills so rapidly that for a time there is a considerable gradient in the other direction. That part of the river valley lying in the central lowland is subject to disastrous spring floods.

As in all of northeastern North America, the surface of the lowlands is covered by a mantle of glacial deposits which locally may be many feet in depth. In addition there are to be found along the coasts marine deposits which indicate that there was considerable postglacial submergence.

FIGURE 3.—The Gorge, Grand Falls, N. B. Below the falls the St. John river rushes headlong through a narrow winding canyon. The hydroelectric development at the falls supplies a large part of the requirements of the province. (Courtesy of Canadian Government Motion Picture Bureau.)

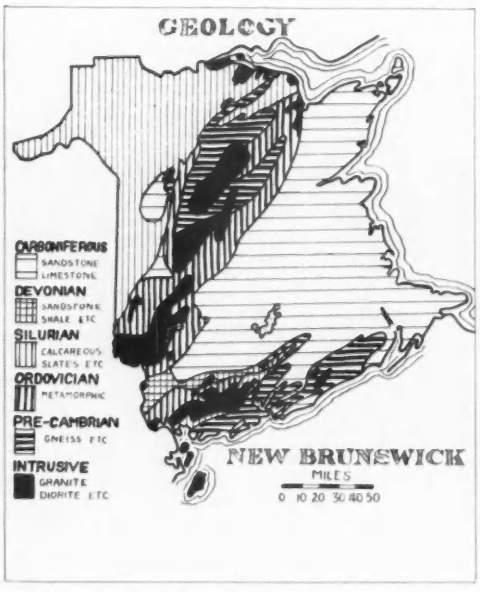

FIGURE 2.—New Brunswick is composed of four physiographic units: (1) the Northwestern Plateau developed on Silurian rocks; (2) the Central Highlands of older folded rocks with intrusions of Devonian granites; (3) the Central and Eastern Lowlands on the Carboniferous sandstones; and (4) the Southern Uplands.

The soils are typically podzols. In the east, under the influence of the Carboniferous sandstones, they are coarse and often infertile, but in the northwest where the soil material is largely derived from calcareous Silurian strata, they are quite fertile. The intervale lands along many of the rivers and the tidal marshes at the head of the Bay of Fundy provide areas of young, unleached, and fertile soils which are agriculturally important.

The natural vegetation of New Brunswick, except on the bogs, tidal flats, and river bottoms, is forest. In the highland areas and on the sandy soils of the eastern coast region the prevailing trees are conifers and black spruce swamps are common. In the rest of the province mixed forests of conifers and hardwoods are found. In the southwestern area numerous raised bogs have been reported.

On the whole, the climate of New Brunswick is continental. Winters are long and cold, interior stations reporting

temperatures of minus 40 degrees Fahrenheit. Spring comes slowly on the eastern coast because of ice in the Gulf of St. Lawrence, but much more rapidly in the St. John valley and the southwest. July temperatures (shown in Figure 6) range from less than 60 degrees Fahrenheit in the central highlands to 66 degrees in the St. John valley and the eastern lowlands. The Bay of Fundy with its swinging tides serves to keep summer temperatures at St. John about four degrees cooler on the average than those of Fredericton. The influence of the sea is also important in keeping the shore regions free of frost during the growing season, whereas in the interior risk of frost damage is very great. On the plateau the average frost-free season is less than two months, while in central highlands frost may be expected at any time.

Rainfall (Figure 7) varies from 33 to 46 inches per annum, being heaviest along the Bay of Fundy shore. Seasonal distribution is fairly uniform, but in the north slightly more than half the precipitation falls in the summer half year, whereas in the south the reverse is true. It is important also, to note that the Bay of Fundy is subject to much fog.

AGRICULTURAL GRADIENTS

The most striking feature of the distribution of farm lands as shown in Figure 8 is that over half the total area is absolutely empty. An area of approximately 7,500,000 acres still remain as Crown land, the cutting rights to

FIGURE 4.—Fredericton, a city of 8,000 people, is the capital of the province. It is the seat of the provincial university and also of a Dominion experimental farm. The metropolis of the central lowland, it formerly carried on a considerable river trade with St. John, 85 miles distant at the mouth of the river. The railway bridge in the middle distance, after giving service for over fifty years, was recently destroyed by an ice jam during a flood. (Courtesy of Royal Canadian Air Force.)

FIGURE 5.—More than three-quarters of New Brunswick is still forested—a tourist's paradise. The photograph shows one of the numerous tourist camping grounds. Excellent gravel roads are found in all parts of the province and many of the main highways are now hard-surfaced. (Courtesy of Canadian Government Motion Picture Bureau.)

which are leased by the government to the timber companies, thus providing considerable revenue. The remainder of the unsettled area is held as private timber lands. This is in striking contrast to conditions in Nova Scotia where little of the land is still retained by the Crown. The greater part of the central highland region of older rocks remains unsettled while settlement is also sparse in the southern upland area. In fact, considerable tracts in the latter area once settled have been abandoned. The greater part of the Silurian plateau is also empty although it will probably not remain so. The Carboniferous lowland contains large empty areas. Much of this land is swampy, the original drainage pattern having been destroyed by glaciation. The areas of closest settlement are found in the valley of the St. John river in Carleton, Victoria, and Madawaska counties, and in that of its tributary, the Kenebecasis in Kings county. Other well settled areas are found at various points along the coast.

The percentage distribution of farm woodland is shown in Figure 9. In general the areas having the largest proportion of occupied land have the

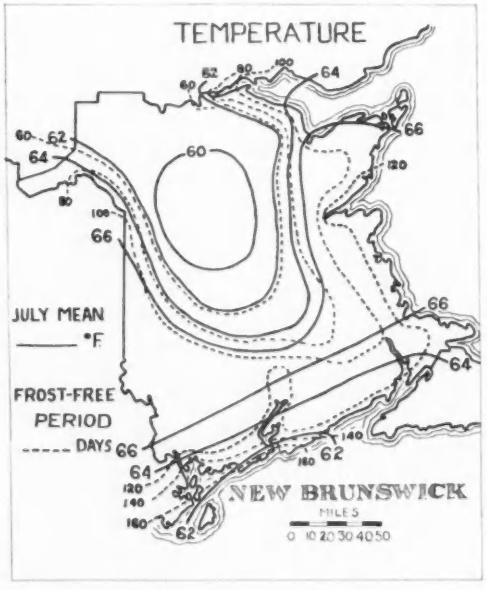

FIGURE 6.—Summer temperatures and frost-free period. The central and eastern lowlands are the warmest in summer while the highlands and the Bay of Fundy shore are cooler. The frost-free period is markedly increased in length near the shores.

FIGURE 7.—The average rainfall in New Brunswick is nearly 40 inches per annum, about equally divided between the cold and warm halves of the year, except in the extreme south where the winters are distinctly wetter.

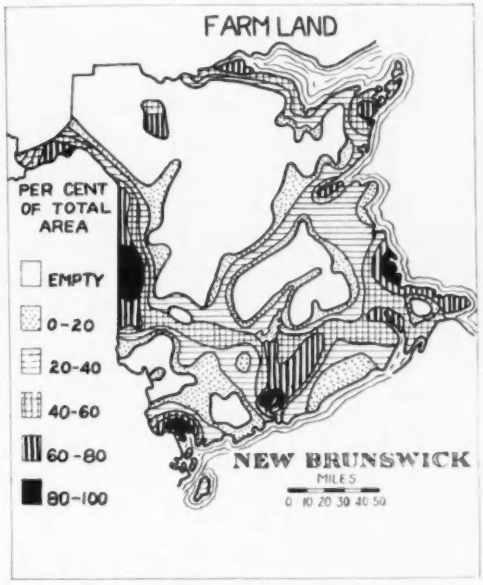

FIGURE 8.—Only a small part of the province is densely occupied, chiefly in the St. John valley and certain shore areas. Over half the province is absolutely empty.

smallest percentage of farm woodland, but in no parish is there less than 20 per cent of the occupied land remaining uncleared. The large amount of farm woodland in the central lowland is due to the undrained condition which has also prevented so much of it from being occupied. Of the occupied land, 2,500,000 acres, or about 58 per cent, remain wooded, which means that in the whole province nearly 90 per cent of the area is still under forest.

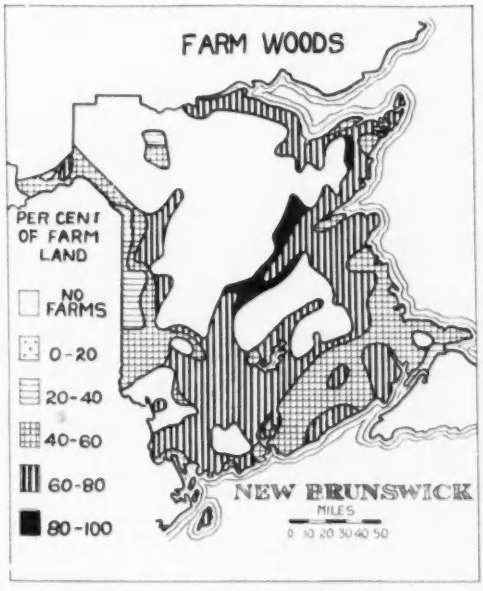

FIGURE 9.—Every farm has a woodlot. There are no parishes with less than 20 per cent of the occupied area left uncleared.

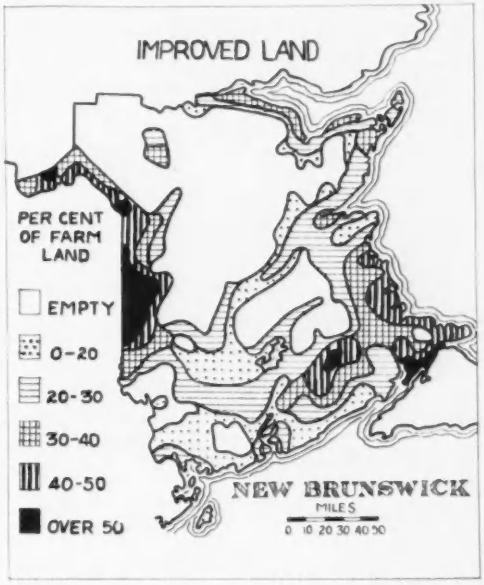

FIGURE 10.—The most highly developed regions of the province are the St. John valley and the southeastern part of the Carboniferous lowland where some sections have more than 50 per cent of the farm area under cultivation.

Distribution of improved or arable land is shown in Figure 10; the pattern in general resembles that of occupied land. A notable exception is found in the Kenebecasis valley, the lower part of which is exceptionally densely occupied, whereas the greater percentage of cleared land is to be found in the upper part of the valley. The greatest development of all is found in the St. John valley where several parishes in Carleton and Victoria counties have between 50 and 70 per cent of the occupied land classed as improved.

Field crops occupy 960,000 acres, 72 per cent of the improved land or 23 per cent of the total farm land. Again the greatest development is to be found in the St. John valley, and areas of lesser but also important concentration are to be found in Kings, Westmorland, and Kent counties. (See Figure 12.)

The most important field crop from the standpoint of acreage involved is hay. (See Figure 13.) It occupies about 600,000 acres or 62 per cent of the total field crop area. Although a greater acreage of hay is grown in the St. John valley, its relative importance is not so great there because of the greater variety of crops grown. In some parts of the province, however, hay is almost the only crop. Such a region is the Tantramar and other tidal marshes in Westmorland county. The hay produced in the province is largely timothy and other grasses, although clovers are also grown.

Next in importance to hay is the oat crop which occupies about 220,000 acres or approximately 23 per cent of the crop land (Figure 14). It is most extensively grown in the St. John valley where in general between 10 and 20 per cent of the farm land is thus utilized.

Potatoes which are the most important field crop in the province from a commercial standpoint, rank third in area of land occupied. In 1930 over 60,000 acres of potatoes were grown with a production of over 12,000,000 bushels, or about 200 bushels per acre, thus ranking among the best producing areas on the continent. Although occupying approximately only 6 per cent of the crop land, they made up more than one-quarter of the total value of all crops produced. Production has since declined somewhat and in 1938 there were about 50,000 acres in potatoes with a production of about 9,000,000 bushels. Figure 15 shows the relative distribution of the potato crop on the basis of the 1930 census figures. The production of certified disease-free seed stock has long been carried on in the New Brunswick potato growing regions. In recent years a determined effort has been made to extend the market for certified potatoes, and in 1937 more than half a million crates were shipped to the South American countries of Argentine and Uruguay. The areas of intensive specialization in potatoes are to be found in Carleton and Victoria counties which adjoin the equally famous Aroostook district of Maine. Smaller areas of

FIGURE 11.—A farm home near Norton in the Kenebecasis valley in Kings county. The buildings are all of frame construction and well painted. Note the fox ranch in the background. (Courtesy Canadian Government Motion Picture Bureau.)

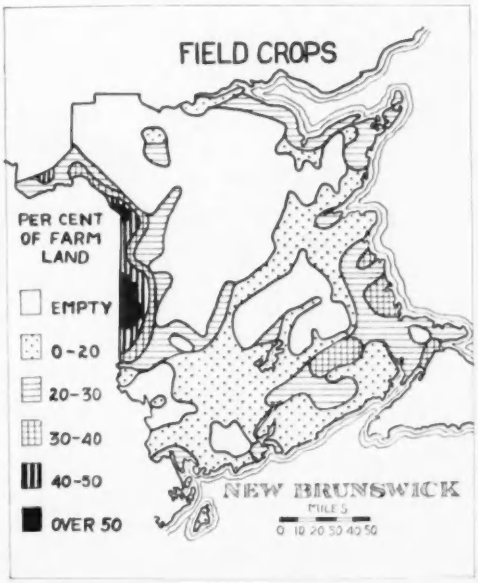

FIGURE 12.—The greatest density of field crops is found in the St. John valley where in some sections about 50 per cent of the farm area is thus utilized. An area of moderate density is also found in the southeastern lowlands.

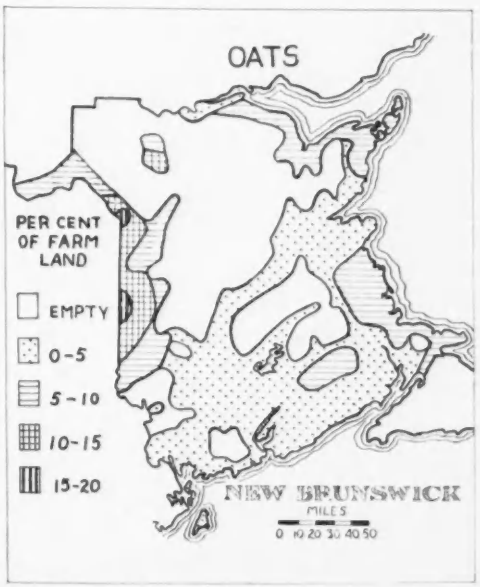

FIGURE 14.—The chief cereal grown in New Brunswick is oats. The St. John valley is the most important oat-growing area, but considerable acreage is grown along the north shore and in the southeastern lowlands.

commercial production are located on the north shore, while the southern part of the province as a rule, produces only for home consumption.

Unlike the neighboring province of Nova Scotia, New Brunswick has not to any extent specialized in apple grow-

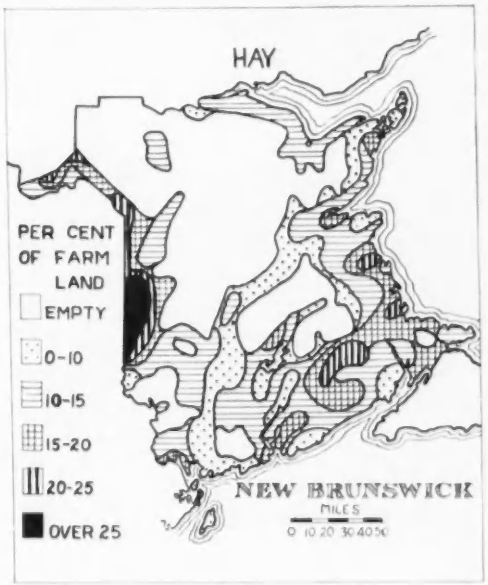

FIGURE 13.—About half the field crop area of the province is devoted to hay.

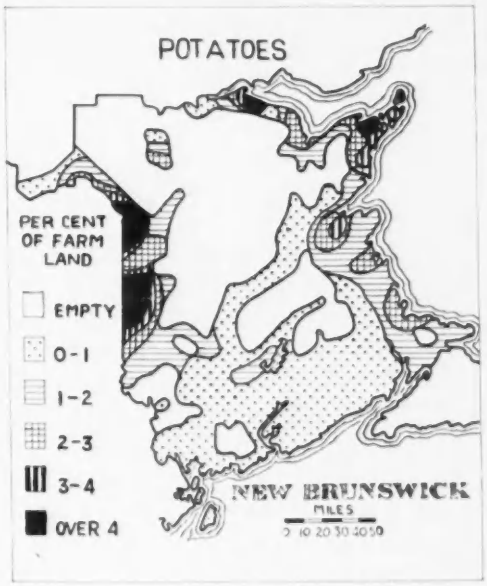

FIGURE 15.—The potato is an important cash crop. Large-scale production is centered in the St. John valley and in certain areas along the north shore.

ing, total production amounting to less than one per cent of the Canadian crop. The chief commercial orchards are found in the lowland counties of Kings, Queens, Sunbury, Westmorland, and York. In small fruits, especially strawberries, however, New Brunswick is on par with Nova Scotia, producing from 1,000,000 to 1,500,000 quarts annually, chiefly in the counties of Kings, Queens, Westmorland, and York.

Livestock comprise one of the mainstays of New Brunswick agriculture, with an annual production valued at about $10,000,000 or about 40 per cent of the total agricultural production. It is to be expected then that a considerable area of farm land will be devoted to pasture. In the whole province about 530,000 acres are so utilized of which 55 per cent may be classed as improved and 45 per cent as natural pasture. The relative distribution of pastureland is shown in Figure 18. The center of the grazing industry is located in Kings county where over 20 per cent of the farm land is pastured. Westmorland county ranks second. In the northern part of the province there is much less pastureland.

Dairy products account for approximately 50 per cent of the value of production of the livestock industry, or 20 per cent of the total agricultural production, and mount to about $5,000,000 annually. The distribution of the dairy industry is indicated in Figure 19 which shows relative numbers of dairy cows in the various districts according to the last census. Production is centered in Kings and Westmorland counties embracing an attenuated area between the cities of St. John and Moncton, which is served by both railroad and hard surfaced highways. The sale of fluid milk to the cities is naturally an important source of income, but there are also butter and cheese factories (Figure 20).

FIGURE 16.—Apple growing is not nearly so highly developed as in the neighboring province of Nova Scotia, nevertheless there are some fine orchards along the lower St. John River. The photograph was taken near Burton in Sunbury county. (Courtesy of Canadian Government Motion Picture Bureau.)

In 1931 the population of the province was 408,219, of which 279,279 (68.4 per cent) were rural and 180,214 (44.2 per cent) actually resided on farms. The distribution of farm population is shown in Figure 21. It can hardly be

said to agree with the map showing distribution of improved land, or indeed any other map which indicates degree of agricultural development. In general the western and southern areas have the lowest densities of farm population while the northern and eastern regions have the highest. One good reason for this is to be found in the greater percentage of Acadians in the population. In Gloucester county, for instance, more than 80 per cent of the people are French speaking. The population of Madawaska county is more than 90 per cent of French extraction, but because farms are more than twice as large, the density of farm population is only half as great as that of Gloucester. Farm income in the latter county, especially in shore settlements, is supplemented by fisheries. Farms in the shore districts are small, the average area per farm in Gloucester county, which has proportionately the longest shoreline, is only half that of the whole province. Another reason which applies equally in all the northern counties is the lumbering industry which gives employment to a great many men during the winter months.

FIGURE 17.—Strawberries are among the most successfully grown small fruits. Maturing late in the season they can be placed on the Boston and Montreal markets after the supply from other sources has been exhausted. (Courtesy of Canadian Government Motion Picture Bureau.)

FUTURE DEVELOPMENT

From a consideration of the geology and physiography of the province it would appear that at least 60 per cent of its area could be converted into farm lands. It is true of course that much lowland area is imperfectly drained and steps would have to be taken to remedy this defect before it could be utilized. It must also be remembered that much of the lowland area is underlain by sandstones and the glacial drift upon which the soils are developed is also sandy and poorly supplied with plant food. The soils themselves are podzols and highly leached, hence they do not lend themselves to crop production without considerable expense for added fertility. Climatically, however, the southern and eastern parts of the province are well favored with a warm, moderately long growing season, well supplied with moisture. The plateau region of the northwest is not so favored climatically; it has a very long and

FIGURE 18.—About one-eighth of the farmland in the province is in pasture. The southern counties lead in this phase of land utilization.

severe winter and a short growing season menaced by both spring and fall frosts. Its soil resources are much greater than those of the lowlands, however, for although they are podzols they are for the most part developed upon calcareous parent materials and have been more slowly leached. The remaining 40 per cent of the area, underlain by metamorphic and crystalline rocks, will undoubtedly be left permanently in forest.

A study of the trends of the past few years throws considerable light upon the question as to which of these empty areas is likely to be occupied in the near future. The population of the whole province has been steadily increasing, but with the exception of St. John and Westmorland where city populations have been increasing, all the southern counties have remained stationary or have lost ground. On the other hand, during the decade 1921–1931, the four northern counties, Madawaska, Victoria, Restigouche, and Gloucester have registered gains. It is significant also that Gloucester, a lowland county, made the smallest gain (8 per cent) whereas Madawaska and Restigouche on the Silurian plateau made gains of 27 and 31 per cent respectively. The

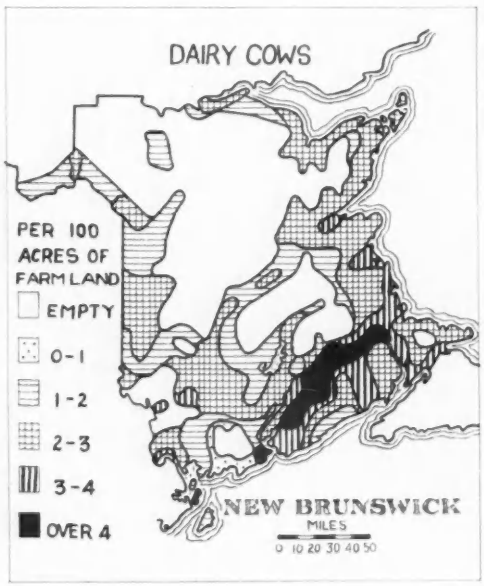

FIGURE 19.—Dairy products account for more than 20 per cent of the total farm production. The dairy industry is centered in the southern part of the province, in the long valley of the Petitcodiac and Kenebecasis rivers, between the cities of Moncton and St. John.

FIGURE 20.—Kings county is the leading dairy district of the province. Besides supplying most of the market milk requirements of the city of St. John it has local dairy establishments such as the one pictured above. (Courtesy of Canadian Government Motion Picture Bureau.)

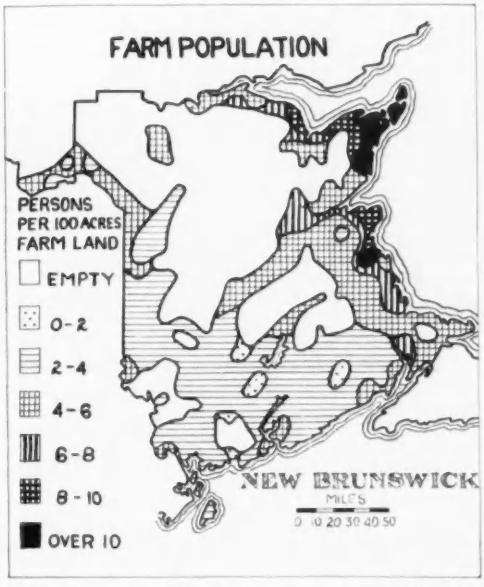

FIGURE 21.—The greatest density of farm population is not necessarily found in the most highly developed agricultural areas. The denser areas in the north and east are due in part to supplementary income from lumbering and fishing, and in part to the higher birth-rate among the Acadian people.

populations of all four counties are predominantly rural.

During recent years settlement in New Brunswick has proceeded at an increased pace. Within seven years, more than 3,500 families have been placed on the land, chiefly in the northern counties. The names of some of the more important new settlements are shown underlined in Figure 1. Not only is development taking place in Madawaska and Restigouche counties on the Silurian plateau, but more than 800 new farms have been occupied in Gloucester county. The expense of the new settlement, amounting to nearly $200,000 in the year 1937, is being borne jointly by several departments of the provincial government assisted by the Dominion Department of Agriculture. More than half of the money has been expended in the building of colonization roads, much of it being paid as wages to the colonists themselves. The rest of the money was paid as land clearing bonuses or spent for seed and building materials.

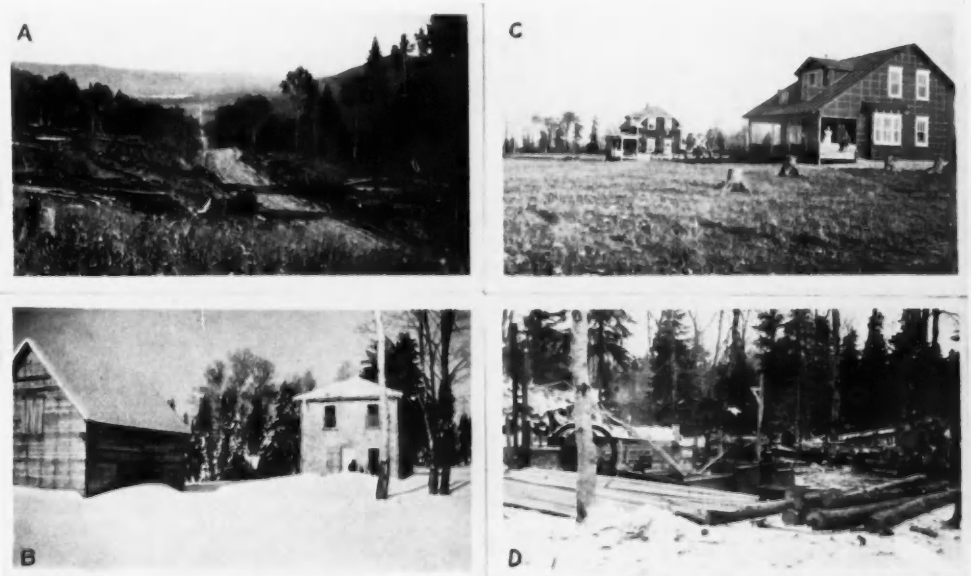

FIGURE 22.—Scenes in the new settlements. A. Colonization road in St. Joseph parish, Madawaska county. B. and C. Neat frame buildings erected by the colonists. D. Small portable saw-mill cutting lumber to build homes for the new settlers. (Courtesy of T. A. MacDonald, Superintendent of Colonization.)

FIGURE 23.—Tobique valley in Victoria county. Note the peaks of the central highlands in the distance. (Courtesy of Canadian Government Motion Picture Bureau.)

The feasibility of colonization of the plateau has already been strikingly demonstrated in the Hazen and Grimmer settlements in Restigouche county where an area of about 100 square miles of Crown land has been occupied by a population of 5,000 under a scheme put into effect about twenty-five years ago. These colonies are now well established with well kept farms and thriving villages. If the whole Silurian plateau and the better parts of the Carboniferous lowland should be colonized to the same density, the population of the province would be more than doubled. It is certain that there will be considerable expansion of the occupied area in New Brunswick, but at the same time there is still room for improvement in utilization of lands already occupied.

DRY-FARMING REGIONS IN UTAH

Norah E. Zink

DRY-FARMING on a scientific basis has been important in Utah since 1903. Shortly before that time a need for additional farm lands in the state became apparent. It would have been possible to meet this need temporarily, or in part, by a more efficient use of the water then available for irrigation and a development of additional storage facilities. The demand for more land was satisfied, however, on a large scale and by a novel procedure. Through the use of practices which conserved moisture, lands which lacked irrigation water were tilled. By this means three or four hundred thousand acres of land previously considered incapable of being farmed were brought under cultivation.

Farming in Utah

Although the state of Utah comprises an area of 52,597,760 acres, only 11.9 per cent of it was in farms in 1935, and but 3.2 per cent of the land of the state was available for crops. It is estimated that not more than 5 per cent of the total area of the state will ever be cropped. Variable light rainfall uncertain in distribution, rough land, steep slopes, thin soil, and alkali are factors which preclude the use of a large additional acreage. Nineteen per cent of the cultivated area was utilized for dry-land crops. Since a large percentage of the dry lands is left fallow each year, the total amount of land devoted to dry-farming is much greater than this. An estimate of 466,000 acres of land suited to dry-farming, about 1 per cent of the area of the state, was given in a United States Geological Survey Report in 1932. While it is possible to raise a large variety of crops by dry-farm methods, only a few are produced in quantity. The distribution of rain with a spring maximum, and the fact that greater profits are derived from wheat production than from any other crop make wheat the dominant crop on the dry lands. Alfalfa, the crop second in importance, covered an acreage only about 30 per cent as large as that of wheat in 1929.

In comparison with other states of the union, Utah does not rank high in the production of wheat. The average acreage for the years 1924 to 1930 was 246,000, ranking it twenty-seventh. Northern and central Utah and southeastern Idaho comprise the intermontane commercial wheat region and together produce annually approximately 20 million bushels of wheat. This is a small surplus area which ships wheat east, west, and southwest. An estimate of the uses of wheat in Utah gives approximately 1,137,000 bushels, or about 21 per cent of the crop, as the average yearly exportable surplus for the years 1924–1929.

In striking contrast to the relatively small amount of wheat produced by the state is the great importance of wheat production within the state. The wheat acreage is greater than that of any other crop except hay. In 1934 wheat was harvested on 201,138 acres, 17.1 per cent of the cropped area of the state, while hay occupied 52.1 per cent of it. In 1930 the largest single cash income from any crop was derived from the sale of wheat. Wheat is produced in all the counties of Utah except Grand County and in several sections wheat growing

is the dominant farm enterprise. Both winter wheat and spring wheat are produced in almost equal amounts, the greater part of the winter wheat being raised on the dry-lands and the spring wheat on irrigated land. Since the yield of winter wheat is low, its acreage is almost double that of spring wheat.

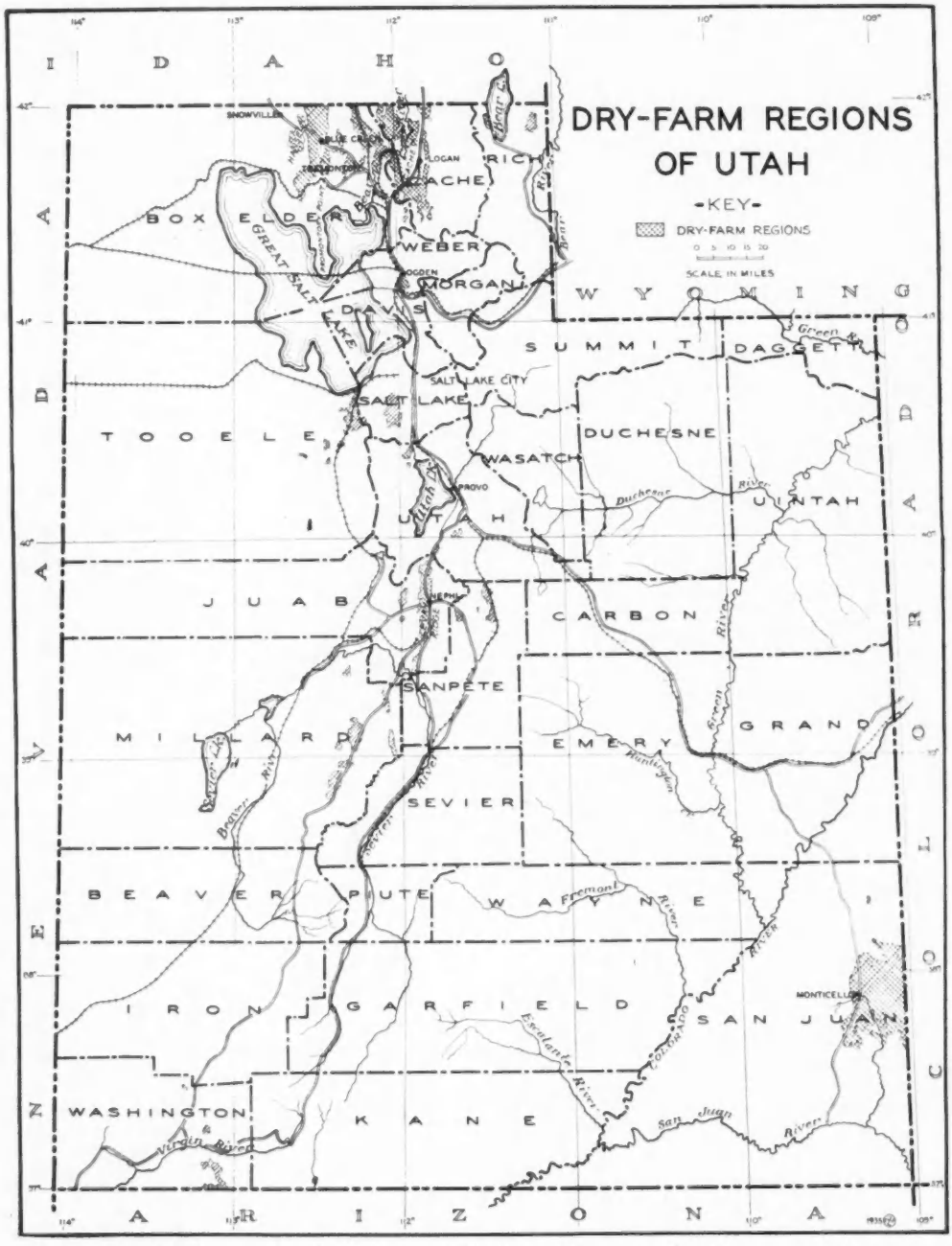

FIGURE 1.—Dry-farm regions in Utah are relatively small in area. For the most part they occupy valleys near mountains or higher plateau lands where the precipitation is somewhat heavier than on lower lands.

The distribution and type of dry-farm areas, to a large extent, depend upon two factors; the amount and distribution of rainfall and proximity to a railroad. The average rainfall for the state is 12.87 inches, a twenty-six year mean for the state (1893–1918) according to J. C. Alter, "Normal Precipitation in Utah," in the September 1919 issue of the *Monthly Weather Review*. That this figure gives little clue to real conditions at a given place is apparent when rainfall data for different stations are compared. The amount of rainfall varies greatly and irregularly from place to place because it is modified by the proximity, height, and relative position of nearby mountains. Since the rainfall of Utah is so light, farming must be carried on either by irrigation or special methods. Dry-farming is the result of scientific efforts to overcome this handicap of light rainfall. Where similar conditions in regard to railroad facilities and the amount and distribution of rainfall exist, as in the central and northern parts of the state, the regions themselves are similar. Southern Utah suffers from lack of railroad services and differs from the rest of the state in the distribution of its rainfall. Therefore, three major types of dry-farming regions have developed, (1) the cash-grain regions in Box Elder County, (2) the regions where a large percentage of the farmers practice both dry-farming and irrigation, such as those found in Cache and Juab Counties, and (3) the strictly dry-farm region of San Juan County which has some commercial grain producers but a large percentage of the dry-farmers produce for their own use, in addition to wheat, other crops, such as potatoes, beans, and forage crops.

The term "dry-farming" brings to the minds of many people the practices employed on the Great Plains in the central part of the United States. Farming without irrigation in the Great Basin, however, is entirely unlike that on the Plains, quite largely because natural factors in the two regions differ greatly. This variance in natural conditions is found especially in the distribution of rainfall, the duration and velocity of wind, and the type of soil. The Great Plains receive two-thirds of their moisture during the six warm months, while western Utah receives about the same amount from December to May inclusive. Coming during the cool season when inhibiting factors are least active, more rainfall can be conserved in the Great Basin than on the Plains. As high as 45 per cent of the rainfall of the fallow year has been saved in the Great Basin while on the Plains the amount does not exceed 33 per cent. The rotation scheme of wheat-fallow is suitable on the Plains, but, because of summer

FIGURE 2.—A dry-farm on a plateau. The farmer's home is in Randolph, Rich County, but he and his family spend their summers on the farm which lies east of Bear Lake. Water is obtained from a spring a short distance from the house.

FIGURE 3.—Dry-farms on the foothills on the west side of Cache Valley. (Courtesy of Dr. D. C. Tingey.)

rain and soil blowing, wheat is generally followed by an intertilled crop, usually corn. The disadvantage of steady and frequently strong winds on the Plains has been met by listing and by using a disk plow which barely turns the stubble over, leaving it near the surface where it holds the soil. Dry-farming in southern Utah more closely resembles the type of farming on the Plains than that in other Utah regions. In these counties an intertilled crop frequently replaces the fallow period, plowing is not so deep as in other sections, less seed is used, and not so much difficulty is experienced in getting the wheat up in the fall. These differences are due, in part, to the lighter soil and greater amount of summer rainfall in these two southern counties.

While Utah dry-farm regions in general resemble one another, they do present many differences which are the result of differing natural conditions or divergences in human utilization.

LOCATION OF LAND DRY-FARMED

The dry-lands in Utah are found in varying locations. Some are high lands in irrigated regions which lie above the water supply, some are low lands for which the water supply is not adequate. Only a small acreage of dry-land, however, lies within irrigated districts. Most of the farms are found in districts for which no irrigation water is available. Some of these dry-land areas are level floors of wide valleys. Others are flat-topped plateaus, gently rolling hilltops, wide lake terraces, or isolated patches of flat ground in narrow valleys (Figures 2 and 3).

Dry-farms sometimes immediately join irrigated farm land, and the farmer of one may operate the other type of land, as in parts of Salt Lake or Cache County. Some dry-lands lie at a short distance from towns as those on the Levan Ridge or the west side of Salt Lake Valley. Others are located a considerable distance from irrigated fields as is the case in Blue Creek and Hansel valleys in Box Elder County. They may even not be connected with irrigated farm-lands at all, of which the San Juan region is a good example.

LIVING CONDITIONS IN THE DRY-FARM REGIONS

As elsewhere in Utah, living conditions on the dry-farms depend largely upon the presence and abundance of water, and upon proximity to an irrigated district. Permanent homes are found on dry-farms where water is available for domestic use and for stock (Figure 5). Since many regions have no water there are no permanent homes in them. Such sections are farmed by men living in neighboring irrigated sections who haul water to the dry-lands during the

busy seasons. These farmers travel to their fields each day, or temporarily remain upon them during the busiest season. When the two types of farming districts are contiguous, or are only ten or fifteen miles apart, the farmer has no difficulty in working both farms, although he may temporarily stay on the dry-farm during the busy season (Figure 6). When the dry-lands lie at a greater distance the farmer must live upon them, at least for the summer season. In such cases he usually spends the balance of the year in an irrigated area but does not necessarily farm land under irrigation. In dry-farm regions, water is obtained from wells or springs, or is hauled into the regions. The shallowest wells, from 10 to 50 feet deep, are in San Juan County; the deepest are probably those in Box Elder County which reach a depth of 300 or 400 feet (Figure 7). Springs are found in parts of Washington, Cache, and San Juan counties. In most of the other dry-farm sections water is taken into the region, and in all of them it is carried from place to place by water wagons or in barrels.

In 1930 tenants operated 42.4 per cent of the farms of the United States; in Utah, they operated only 12.2 per cent. Webb in "The Great Plains" says,

> "Tenants cannot live in the arid region. They depend on crops and crops are uncertain. . . . The tenant has no reserve financially, and only people with reserve resources can remain in an arid region in time of drought."

Although there is little actual tenancy on the dry-farms of Utah, it is a common practice, particularly in the northern and central parts of the state, to lease land.

Except in San Juan and western Box Elder counties, a large percentage of the farmers carry on dry-farming in conjunction with irrigated farming. Only in these two sections, which are situated far from irrigated districts, has the land been developed by men who work no irrigated land. Blue Creek and Hansel Valley lie some fifty miles from Cache Valley, the original home of most of the dry-farmers of western Box Elder County. These farms are strictly commercial wheat farms, because most of them are owned by men who live at too great a distance to operate successfully both a dry farm and an irrigated unit, and, in order to be profitable, large-scale production is necessary. In San Juan County most of the farmers live upon the dry-farms, and, since there is

FIGURE 4.—Dry-farms in Cache Valley lie above the irrigation ditches and even extend to the top of the low limestone hills on the west side of the valley. (Courtesy of Dr. D. C. Tingey.)

almost no irrigated land in or near the dry-farm area, only a few of them own irrigated land. With heavier rain and a larger percentage of it coming in summer, these farmers raise a variety of crops (Figure 8).

LAND UNITS

Dry-farm units in Utah generally do not reach the proportions which are found in some other dry-land areas of the United States. In Whitman County, Washington, the average size of wheat farms is stated to be 496 acres. Although the average amount of land cropped by each farmer in western Box Elder County is over 400 acres, for the most part the Utah average of dry-land individually owned is much lower.

FIGURE 5.—A home on a large dry-farm in Hansel Valley. In the background the state well is seen. The owner lived on this farm over fifteen years, then retired, going back to Logan to live.

The smallness of dry-land units in Utah is probably due to the following factors: (1) small size of the areas adapted to dry-farming, (2) financial condition of the people in Utah who are interested in dry-farming, (3) means of acquiring the land, (4) division of lands through inheritance. Dry-farm holdings vary greatly in size in different parts of the state, ranging from one acre to 2,000. Largest average-sized farms are found in Blue Creek and Hansel valleys in Box Elder County, where the average size is 633 and 983 acres respectively. Few farms in either region contain less than 100 acres. These large acreages result from the manner of acquiring the lands, their recent utilization for dry-farming, and their distance from both irrigated sections and the homes of the owners. The smallest dry-farm holdings are those in Mendon, near Logan in Cache County. This is probably due to the fact that some of the small acreages were formerly irrigated, but since there is no water for them at present they are classified as dry-land. Many of these will receive water again upon the completion of the Hyrum Dam on Little Bear River, when about 1,000 acres of land now classed as dry-land will be put under the ditch. The average size of Mendon dry-farms will doubtless then be larger. Another factor operating here, as elsewhere, is the division of farms upon the death of owners. Other small holdings contain land with unsuitable soil or uneven topography. This is illustrated by the poorer lands at the edge of Levan Ridge and in Upper Blue Creek Valley.

Assessed values for dry-farm land in Utah vary from an average of $5.07 in San Juan County to $23.87 in Weber County. These average values for counties are shown in Table I. For the most part they are a reflection of the degree to which a region can produce wheat and of the cost of shipping it to a market. Presence of water for culinary and stock use and proximity to an irrigated section are also factors in establishing values.

The average amount of wheat which an acre can produce is an important factor in determining value of the land. The highest priced dry-farm lands are in Weber, Cache, and Morgan counties. Due to their location in the northern part of the state, and to the presence of mountains and higher altitudes, rainfall in these counties is heavier and more effective, and therefore yields are higher than in other Utah counties.

Low-assessed values for dry-farm lands are found where yields are low, as in Rich, Sevier, Washington, and Millard counties, and in parts of Tooele County. These low yields are the result of lack of effective rainfall, of high temperatures and evaporation, of poor soil conditions and short growing season.

FIGURE 6.—A trailer used in summer as a temporary home on the dry-lands west of Salt Lake City. The wheat stacked at the side of the implement shed is to be used as seed.

TABLE I

AVERAGE YIELDS, RAINFALL, TEMPERATURE, AND LAND VALUES IN NINE DRY-FARM COUNTIES

County	*Bushels per Acre***	*Rainfall in Inches**	*Mean Yearly Temperature**	*Assessed Land Values per Acre*
Cache	18.3	16.39	47.4	$22.14
Box Elder	16.0	13.85†	47.9	11.61
San Juan	14.0	17.38	47.4	5.07
Rich	13.8	10.33	....	7.84
Salt Lake	13.2	16.23†	51.6	12.88
Juab	12.5	12.25	47.0	11.62
Tooele	10.0	13.72†	49.9	5.63
Millard	9.1	15.10	47.4	7.30
Washington	7.0	8.81‡	58.9	7.19

*Temperature and rainfall averages for San Juan, Tooele, and Millard counties obtained by averaging records from two stations.

**Average yields obtained from data in the Fifteenth Census.

†These averages are probably higher than the rainfall found within the dry-farm regions.

‡Rainfall in the dry-farm regions of Washington County may be a little heavier than indicated in the table.

Distance from a railroad or market is an especially important factor in the valuation of land in San Juan County, which has a high average rainfall and yield. If the dry-farming sections are near an irrigated region, land values are often higher.

Within regions only a few factors, such as type of soil, length of growing season, and topography, operate to differentiate the value of the land of these. The type of soil is of greatest importance. Two other conditioning factors are frost and uneven topography.

There are two patterns of holdings which show plainly in maps of holdings in dry-land regions: (1) compact, rectangular holdings, (2) scattered holdings. Compact rectangular farms are found in all of the dry-land regions. These are, to a large extent, the result of the rectangular system of surveys used by the government and prescribed by the Homestead Laws. The San Juan area reflects most plainly the effect of these laws, because a large part of the land dry-farmed in San Juan County has been procured by homesteading. In only one district of the state do holdings vary to any extent from the rectangular shape and plots made up of

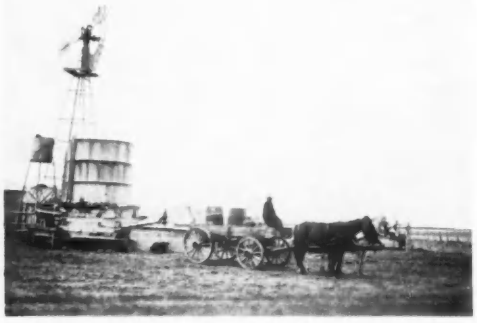

FIGURE 7.—Hauling water from the state well in Hansel Valley. The farmer gives a small fee to pay for the pumping.

multiples of 40 acres. This is in Cache Valley where fields are not a quarter section or half that amount in size, but are odd-sized, such as 62, 26, 153, or 385 acres. This condition is not common on the dry-lands where lands are usually owned by halves or quarters of quarter-sections. This difference may be traced partly to the fact that lands were procured here before establishment of the national survey. Scattered holdings are typical of Utah farmlands and are found in both irrigation and dry-land regions, with the exception of San Juan County where farmers have but few separated fields. The condition is most pronounced in Cache County and is due to the manner in which the land was procured, and to the fact that part of it was formerly classified as irrigated and grazing land. When settlements were made, both grazing and irrigated land were allotted to each settler.

THE WHEAT

Some relationship between rainfall, temperature, and yields can be seen, but it is not so great as it would be if climatic data were available for the exact area farmed. Yields in Cache, San Juan, and Salt Lake Counties are probably higher because of heavier rainfall. Rich County has both high latitude and high altitude (6,000 feet) which results in a short season. Tooele, Millard, and Washington counties have high evaporation, which is reflected in low yields. Wheat produced in the different regions varies both in amount and quality. That raised on most of the dry-farms is classified as hard red winter wheat of the Turkey red variety, that of the highest grade being produced where conditions of growth are most difficult.

FARM PRACTICES

A few localities have farm practices peculiar to their parts of the state. Some of these peculiarities, such as outdoor storage and hail insurance, are closely related to natural factors. Others are a response to personal inclinations of the farmers or to commercial demands. The manner of caring for grain after it has been harvested varies somewhat

FIGURE 8.—Corn on a San Juan dry-farm. There is a small orchard in the background. San Juan dry-farms, with trees and crops other than small grains, have an aspect entirely different from dry-farms in northern and central Utah.

throughout the state for several reasons, such as slight climatic differences, distance from loading points, and relative isolation of the region. In several dry-farm sections of northern Utah, but especially in Blue Creek and Hansel valleys, where there is no rainfall in the summer, farmers store their grain in the open with no protection (Figure 10). Across the extreme northern part of the state from east to west stretches a hail belt about fifteen miles wide. Therefore, in Box Elder and Cache counties many farmers during good years consist of sagebrush or small trees. Crops, too, differ and are more varied with the addition of beans, potatoes, and forage crops. The large farms of the dry-land regions of northern and central Utah produce wheat as a cash crop. It is true some small farms within these regions raise only enough wheat to furnish flour for the farmer and feed for his animals, but as a whole, these areas may be considered cash-crop regions. Even Washington County, although resembling San Juan County in the type of crops raised, produces cash crops

FIGURE 9.—This is the common type of granary found throughout northern and central Utah.

insure their wheat for a short period immediately preceding harvest. Use of wheat straw, which is plentiful and therefore cheap, varies with the locality and the price of hay. When the price of hay is low, straw is often left on the fields and plowed under. The higher price of hay in the last few years has resulted in its replacement by straw on the market. West of Salt Lake City on the dry-lands, which are partly owned by men from a poultry-producing district, straw is baled for their use.

Dry-farm regions in northern and central Utah look much alike. Their entire areas are devoted to raising wheat. In southern Utah only parts of the regions are in crops; the rest still carries the native vegetation which may almost entirely. It is only in San Juan County that a large percentage of the farmers produce a variety of crops for their own use.

SUMMARY

In the dry-farming industry of Utah the most important natural factors are amount and distribution of rainfall, and depth and type of soil. Minor factors are length of growing season, temperatures at critical stages of plant growth, and amount of evaporation. The most interesting geographical adjustments deal with land ownership, location of homes of dry-farmers, relation of dry-farming to irrigated farming, certain farm practices peculiar to dry-farming, and wheat yields. They are closely

FIGURE 10.—Grain stacked against the implement shed. The farmer was waiting for a higher price.

related to the natural conditions but are also partly the result of cultural conditions.

In general, the industry is carried on today much as it has been in the past fifteen or twenty years. Various changes in practices, however, have taken place, and are now in operation. Some of the changes relate to the operation of land units, and the storage and shipping of wheat, and are as follows:

1. It is probable that land units throughout the state have not changed greatly in size, but there seems to be a tendency for fewer people to operate the land, thus confining the actual work to lessees and men who do custom work.

2. After the extravagant investment in machinery which followed the period of big yields and high profits there has been an effort to use machinery coöperatively, and a tendency to return to horse-power.

3. Farmers wish to store their own wheat and sell when conditions demand or prices invite. They are even beginning to venture in wheat speculation. As in other parts of the country, more wheat is stored and shipped in bulk, which saves not only the cost of the bags but also the cost of sacking it. As a result of this movement the Blue Creek warehouse, which is owned by the Farmers National Grain Corporation, has been closed several seasons.

4. Transport of wheat by motor has increased. Not only are Juab County farmers hauling their grain to market, but also farmers in other regions. From Hansel Valley and Blue Creek and even from southern Idaho, wheat is no longer hauled just to the loading points on the railroad at Kosmo and Lampo, but is taken to the grain market at Ogden.

5. County assessors in the various counties are becoming interested in learning what the assessed values of land are in other parts of the state, and the state itself is attempting to equalize these dry-land values.

Although large areas formerly used for dry-farming have been abandoned, much land is still being farmed with small profit. The United States Government is trying to remove from use these marginal and sub-marginal areas. At present the Administration has two projects in Utah involving the purchase of poor farmlands for conservation purposes. These projects include 30,000 acres in the Widtsoe Land-Use Adjustment Project which is located in Garfield County, and 48,000 acres in the Central Utah Dry-Land Adjustment Project located in Juab and Tooele counties. This land will be used for grazing purposes.

The dry-farming industry brought into profitable cultivation many thousand acres of land. On the other hand, native vegetation on large stretches was removed at the time the land was brought under cultivation. Formerly

some of this land was covered with meadows of bunch and wheat grass. After being cleared for dry-farming, the native vegetation does not return for a long period of time and the land lies almost bare, subject to destructive erosion. Thus, these areas not only are withdrawn from use for grazing purposes but through erosion become utterly useless and a menace to other lands. The government is now endeavoring to curb this soil erosion and supervise the use of the land so that its indigenous vegetation will return and these regions can again be used for grazing.

By 1933 dry-farming in Utah had been established somewhat firmly upon a scientific basis. Many limitations of the industry as well as its possibilities were recognized. The drought years had already caused a shrinkage in acreage and the Government removed some of the farmers on sub-marginal lands. A study of this industry in Utah from its inception up to the present would seem to permit the following statements concerning its future, although Government policies and increase in scientific knowledge may make unexpected changes. The land utilized for dry-farming during the drought years (1931–1934) will probably continue to be so used. No great extension of acreage seems possible, although the building of a railroad into the San Juan area would increase the amount farmed there. Series of wet years and high prices will coax farmers to return to low-yielding lands. The renewed use of such lands for dry-farming is discouraged and prohibited by present government policies as expressed in the plans of the Resettlement Administration, Soil Conservation Act, Taylor Grazing Law and the proposed "Ever Normal Granary" plan. On the other hand, although dry-farm wheat yields are low, the high protein content of the wheat partially compensates for this, and the use of these lands for dry-farming meets a social as well as economic need in the development of Utah. Therefore, it would seem that the acreage would probably not decline far below the 1933 level.

Within the industry, improved farming techniques will be utilized, especially by the areas least progressive at present. New types of drought-resistant crops, perhaps some fodders, new strains of wheat, such as a smut-resistant variety for northern Utah, will increase production. It is probable that the tendency to consolidate holdings or land operated will proceed more rapidly than division of property upon the death of owners. Coöperative farming may again become an important factor. Most changes in the industry may be expected from additions to scientific knowledge, the position of the United States in the World Export Trade, and shifts in government planning as related to agrarian policies and trade barriers.

Although the dry-farming industry has never realized the dreams of its founders, even at its period of greatest expansion during the years 1916 to 1922, nevertheless it has brought into wheat cultivation some 200,000 acres of land. In 1934 the land farmed by dry-farm methods constituted 15.3 per cent of the cropped land. Through its utilization in this manner the very low returns per unit area resulting from the use of the land for grazing have been increased to the higher returns derived from dry-farming.

BOOK REVIEW

The Japan-Manchoukuo Year Book, 1939, 1200 pp. and map. Published by The Japan-Manchoukuo Year Book Company, Tokyo, Japan, Agents H. W. Wilson Company, New York, 1939. Price $7.50.

The sixth annual issue of the Japan-Manchoukuo Year Book contains a wealth of material of interest to the geographer. The bulky volume presents detailed descriptive information, and hundreds of tables concerning all phases of Japan and her protectorate, Manchoukuo. The discussion of the two countries is kept separate, although the influence of the Japanese is very evident in the Manchoukuo section.

Numerous significant trends may be noted from even a cursory study of the book. Especially striking to the geographer is the rapid rate at which industrialization has taken place. In 1936, 43 per cent of the people were engaged in agriculture in Japan, but "the value of output from agriculture, including silk, is about one-third that from the manufacturing industries." The index of industrial production is estimated at 233 for 1937 (1926, 100). The manufacturing industries have also changed, especially since 1934, from an emphasis on textiles to a concentration on heavy industries. The index for metallic industries in 1937 is 605, for machines and tools, 458; the two industries account for 36.2 per cent of total value of production (1937) in contrast to 24.9 per cent for textiles. In 1926 they were 14.2 per cent and 41.4. per cent, respectively.

After reviews of conditions in the Japanese colonies, follows a section of 312 pages on Manchoukuo. As in the discussion of Japan, there is a preliminary section on the geography (including relief, geology, climate, flora and fauna).

The development of Manchoukuo by Japanese companies is well revealed. For example, at the end of 1937, over 3,106 million Yen had been invested in Manchuria, mostly in transportation (64 per cent) and manufacturing (23 per cent); one-half of this sum had been invested in the period, 1932–1937. In addition, there were the "Manchurian Incident Expenses" of 1,310 million Yen, which seem to be continuing although the incident took place in 1931.

A supplement on "Japan's Economic Position in China" traces economic and monetary developments in this new area of Japanese expansion. The figures are mainly for pre-war conditions. The trade data show the decline of Japanese participation in Chinese trade since 1926 (index, 100; 27.7 per cent) to 1937 (index, 30; 16.4 per cent); this is one of the major factors in the present struggle. Summaries are given of the official plans for economic revival and development under Japanese investment in north and central China.

In the appendix are a "Who's Who," a Business Directory, tables on the Konzerns (big companies, eight of whom own over 25 per cent of the total paid-up capital of entire Japan), a bibliography, and a list of learned and social institutions (including The Association of Japanese Geographers, The Association of Geographers and Geologists, and the Geographical Society of Tokyo). It ends with a rather complete index. A large map of Japan and Manchoukuo accompanies the volume.

Much of the data are for 1937, but they are the most recent data available. There are indications that such detailed information will not again be available, especially in English.

SHANNON MCCUNE

ECONOMIC GEOGRAPHY

A QUARTERLY journal of economic geography published by Clark University for the benefit of geographers, economists, teachers, professional and business men, and all who are interested in the intelligent utilization of the world's resources.

Subscription rates are $5.00 the year in the United States and its Territories; $5.50 the year beyond the borders of the United States, except to charter subscribers.

The July issue of Volume 15 contains the following articles:

Agriculture in Finland, William R. Mead, London School of Economics and Political Science, London, England.
Studies of River Development in the Knoxville-Chattanooga Area, G. Donald Hudson, Aelred J. Gray, Harold V. Miller, Robert M. Howes, Edward N. Torbert, Christian C. Crossman, and Victor Roterus, Tennessee Valley Authority, Knoxville, Tennessee.
Water in the Laramie Region of Wyoming, Carol Y. Mason, Northwest Missouri State Teachers College, Maryville, Missouri.
Cheese Region of Southeastern Wisconsin, Loyal Durand, Jr., University of Wisconsin, Madison, Wisconsin.
Land Utilization of the University Lake Drainage Basin, F. C. Erickson and W. H. Levitt, University of North Carolina, Chapel Hill, North Carolina.
The Soya Bean in Manchuria, G. F. Deasy, University of Cincinnati, Cincinnati, Ohio.
Distribution of Sugar Cane Production in Cuba, Helen M. Boyer, Washington Court House, Ohio.

The April issue includes:

The Port of Bristol, F. Walker, University of Bristol, England.
Agriculture in Finland, William R. Mead, The London School of Economics and Political Science, London, England.
Land Tenure in the Leading Types of Farming of Puerto Rico, Rafael Picó, The Catholic University of America, Washington, D. C.
Granite Industry of Quincy, Massachusetts, J. Nelson Clifford, Bridgewater State Teachers College, Bridgewater, Massachusetts.
Climate and Agriculture in California, M. K. Bennett, Food Research Institute, Stanford University, California.
Geography of the Fiber-Flax Industry, People's International College, Elsinore, Denmark.
Land Forms, Settlement, and Land Utilization in the Southern Allgäu, A. F. A. Mutton and A. E. Adams, University of London, England.
The Upper Thracian Plain in Bulgarian Agriculture, Anastas Beshkov, High School of Commerce, Svishtov, Bulgaria.
Block-Pile System of Statistical Maps, Erwin Raisz, Harvard University, Cambridge, Massachusetts.
The Pulque Industry, Raymond E. Crist, University of Illinois, Urbana.
Cacao Industry of Brazil, Elizabeth Keithan, Asheville Normal and Teachers College, Asheville, North Carolina.
United States Soybean Industry, George H. Primmer, State Teachers College, Duluth, Minnesota.

The January issue includes:

Field Observations on the Canton Delta of South China, Glenn T. Trewartha, The University of Wisconsin, Madison.
Population Studies in Three American Counties, Barnard Joy, U. S. Department of Agriculture, Washington, D. C.
The Aland Islands, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
Farm Distribution in Nova Scotia, D. F. Putnam, University of Toronto, Canada.
Pioneer Economy of Sakhalin Island, Herman R. Friis, The National Archives, Washington, D. C.
Silver Peak and Blair; Desert Mining Communities, John C. Weaver, The University of Wisconsin, Madison.
Foundations of Chinese Life, George B. Cressey, Syracuse University, Syracuse, New York.

The October issue of Volume 14 includes:

Panama Canal Traffic, Carol Y. Mason, Northwest Missouri State Teachers College, Maryville, Missouri, and Adagrace Rowlands, University of Wisconsin, Madison, Wisconsin.
Anthracite Region of Pennsylvania, Raymond E. Murphy and Marion Murphy, Pennsylvania State College, State College, Pennsylvania.
Isle Royale; Potential National Park, George H. Primmer, State Teachers College, Duluth, Minnesota.
Water Plan for the Great Valley of California, H. J. Wood, University of London King's College, England.
Cotton Regions of Mexico, Samuel N. Dicken, University of Minnesota, Minneapolis.
Norway's Industrialization, Claudia Thomson, United States Department of Agriculture, Washington, D. C.
Swine Industry of China, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
Mineral Wool Industry of the United States, William D. Thornbury, Indiana University, Bloomington, Indiana.
Blue Mountain Coffee of Jamaica, Harry E. Hoy, University of Illinois, Urbana, Illinois.
Some Recent Trends in Alaskan Commerce, Willis B. Merriam, Eastern Washington College of Education, Cheney.
Changing Frontier in the Columbia Basin, Albert L. Seeman, University of Washington, Seattle, and Harold E. Tennant, Wenatchee, Washington.

Single copies of back numbers of Volumes 1 to 5 inclusive will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volumes 6 to 14 inclusive will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

Send all subscriptions and orders to

ECONOMIC GEOGRAPHY,
Clark University, Worcester, Mass., U. S. A.

ANNOUNCEMENT

IN subsequent issues of ECONOMIC GEOGRAPHY Dr. Samuel van Valkenburg will continue the *Agricultural Regions of Asia*. In later issues Dr. Homer L. Shantz, until recently President of the University of Arizona, will contribute his series on *Agricultural Regions of Africa* which, upon conclusion, will complete the most inclusive geographic discussion of the world's agriculture thus far established.

To obtain the complete series of these extremely valuable articles, which present for the first time on such a comprehensive and accurate basis the significant divisions of the world's most important industry, it will be necessary to subscribe at once for ECONOMIC GEOGRAPHY, and to order the several back numbers.

In addition to this series of articles on agriculture, other series are being initiated; every issue will also contain four or five articles dealing with urban and regional geography, with problems of land utilization, with programs of development of resources, with commerce, with transportation, with health, and with the hundred and one other subjects that are of present geographic interest, all by the most competent and best-informed authorities in their respective fields. ECONOMIC GEOGRAPHY is indispensable to the intelligent citizen.

The subscription price to all new subscribers in the United States and possessions is $5.00 the year or $9.50 for two years. To all foreign countries, $5.50 the year or $10.00 for two years. A few complete files from the first issue up to, and including, the numbers for 1939 are still available; they will be sold only to persons or institutions having special interests in the field of economic geography. Prices on such complete files will be quoted on application.

THE STAFF

WALLACE W. ATWOOD, *Editor*

W. ELMER EKBLAW, *Assistant Editor*

Associate Editors
OLIVER E. BAKER
CLARENCE F. JONES
SAMUEL VAN VALKENBURG
WALLACE W. ATWOOD, JR.

CONTRIBUTING EDITORS

PERCY M. ROXBY, The University of Liverpool, England.

GRIFFITH TAYLOR, University of Toronto, Canada.

ALBERT DEMANGEON, The University, Paris, France.

PAUL TELEKI, The University, Budapest, Hungary.

V. C. FINCH, The University of Wisconsin, Madison, Wisconsin.

ELLSWORTH HUNTINGTON, Yale University, New Haven, Connecticut.

CHARLES C. COLBY, The University of Chicago, Illinois.

HELEN M. STRONG, United States Department of Agriculture, Washington, D. C.

NELS A. BENGTSON, The University of Nebraska, Lincoln, Nebraska.

LAWRENCE MARTIN, Library of Congress, Washington, D. C.

C. LANGDON WHITE, Western Reserve University, Cleveland, Ohio.

"Nature has been so silent in her persistent influence over man, that the geographic factor in the equation of human development has been overlooked."

ELLEN CHURCHILL SEMPLE.